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Miyake

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(54) **IMAGE PROCESS APPARATUS, IMAGE PROCESS METHOD AND COMPUTER-READABLE STORAGE MEDIUM**

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(52) **U.S. Cl.** **348/581**; 348/458; 348/561; 348/704; 348/441; 382/299; 382/298

(58) **Field of Search** 348/458, 581, 348/439.1, 561, 625, 556, 252, 445, 913, 441, 440.1, 704; 382/298, 264, 299, 266, 300, 269; 358/1.2; 345/127, 130, 439; H04N 1/393

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(57) **ABSTRACT**

Input image information from an input terminal is stored in a line buffer for several lines and smoothed, and then an interpolation value for plural pixels is obtained by an interpolation unit. Further, maximum and minimum values are detected from information of a noticeable pixel and its peripheral pixels. An arithmetic unit performs calculation by using these detected values (interpolation value, maximum value and minimum value) and a predetermined value to obtain a high-resolution output value h(k). By this calculation, a jagless clear high-resolution image can be obtained even in a case where a contrast of inputted low-resolution information is deteriorated.

14 Claims, 12 Drawing Sheets

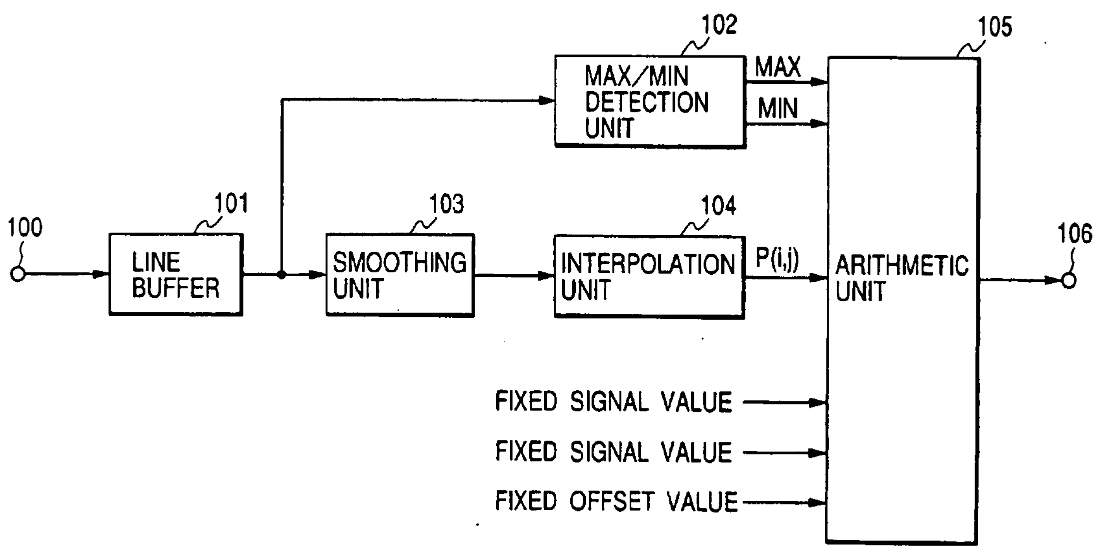


FIG. 1

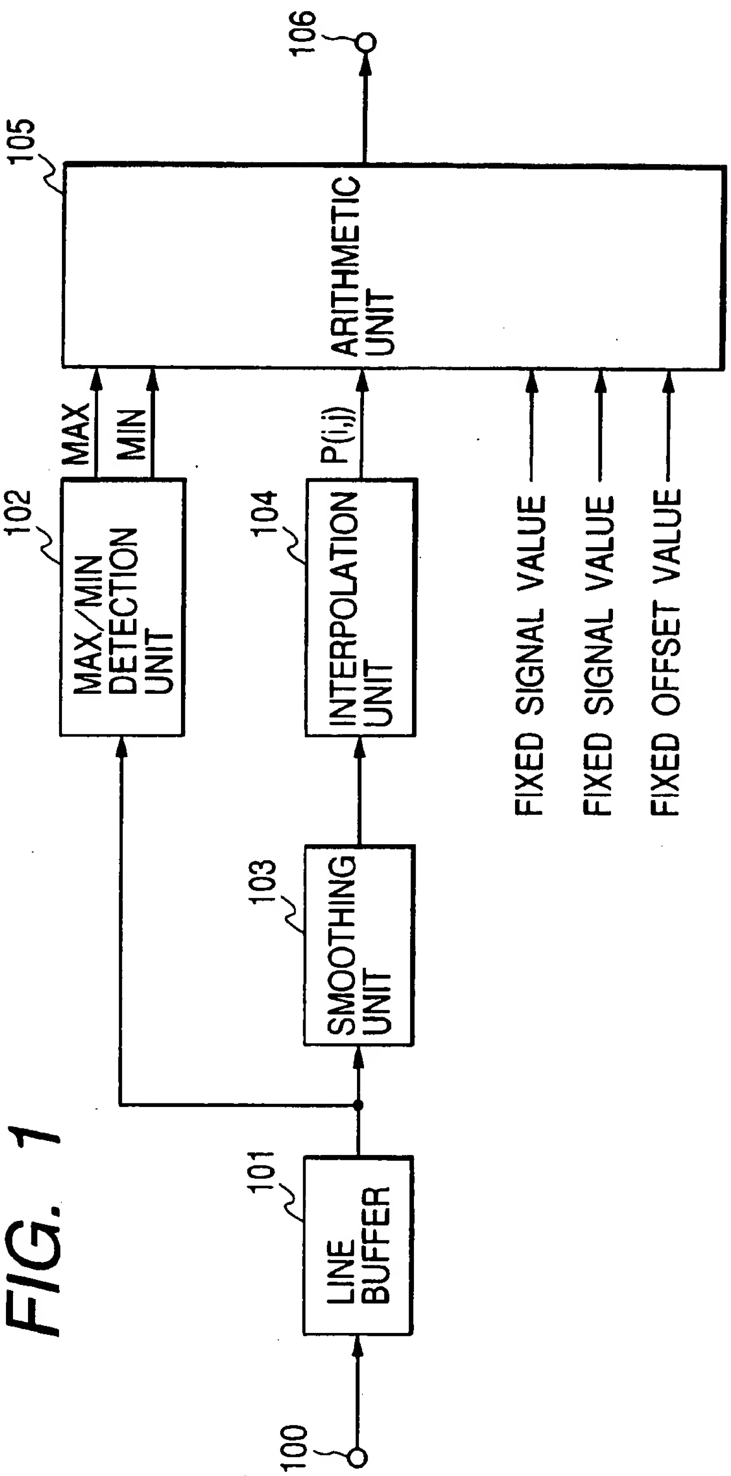

100
101
LINE BUFFER
103
SMOOTHING UNIT
102
MAX/MIN DETECTION UNIT
MAX
MIN
104
INTERPOLATION UNIT
P(i,j)
FIXED SIGNAL VALUE
FIXED SIGNAL VALUE
FIXED OFFSET VALUE
105
ARITHMETIC UNIT
106

FIG. 2

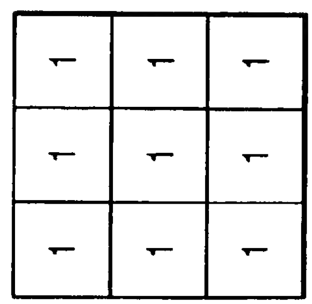

1 1 1
1 1 1
1 1 1

FIG. 3

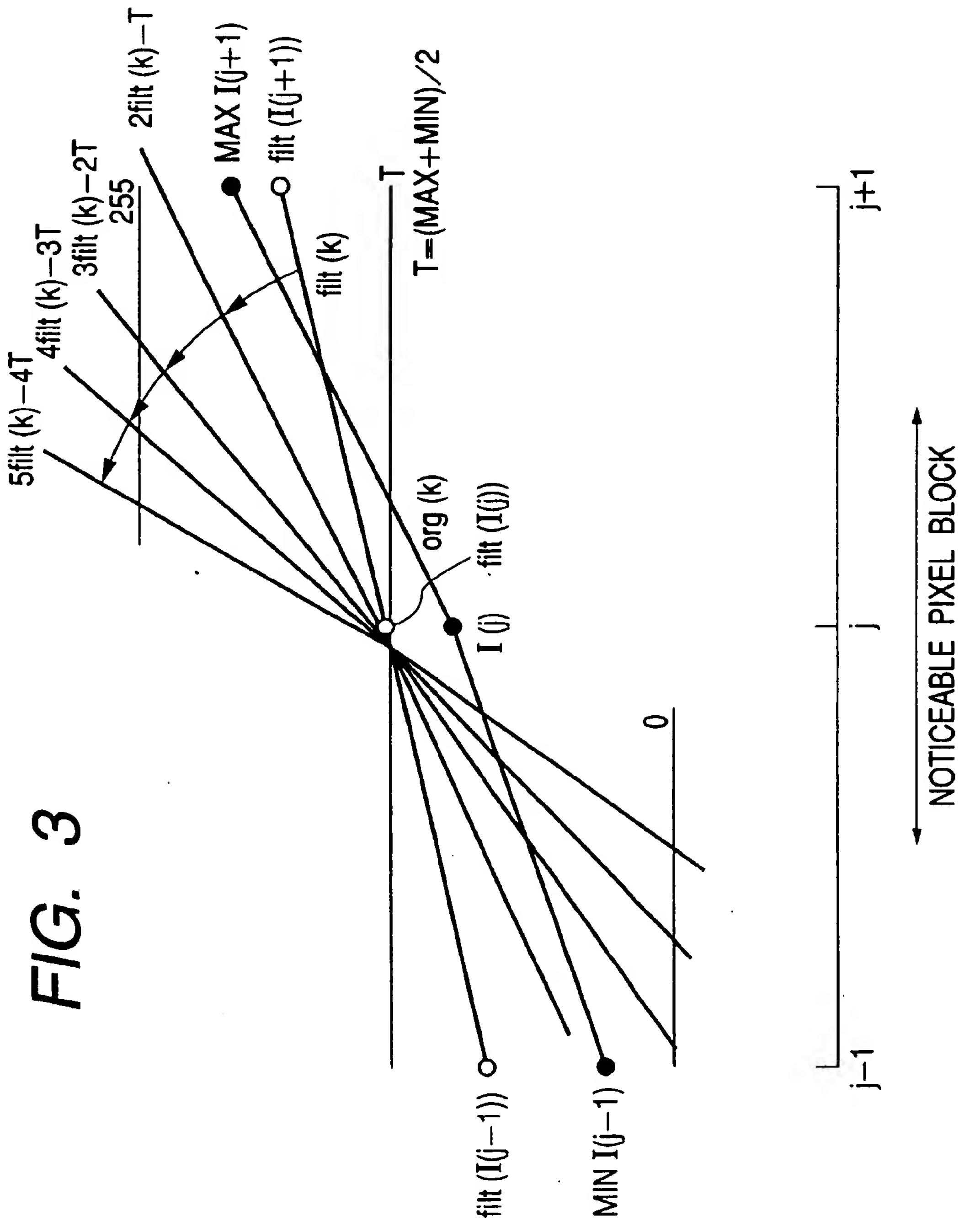

2filt (k)−T
MAX I(j+1)
filt (I(j+1))
T
T=(MAX+MIN)/2
3filt (k)−2T
255
4filt (k)−3T
5filt (k)−4T
filt (k)
org (k)
filt (I(j))
I (j)
0
filt (I(j−1))
MIN I(j−1)
j−1
j
j+1
NOTICEABLE PIXEL BLOCK

FIG. 4

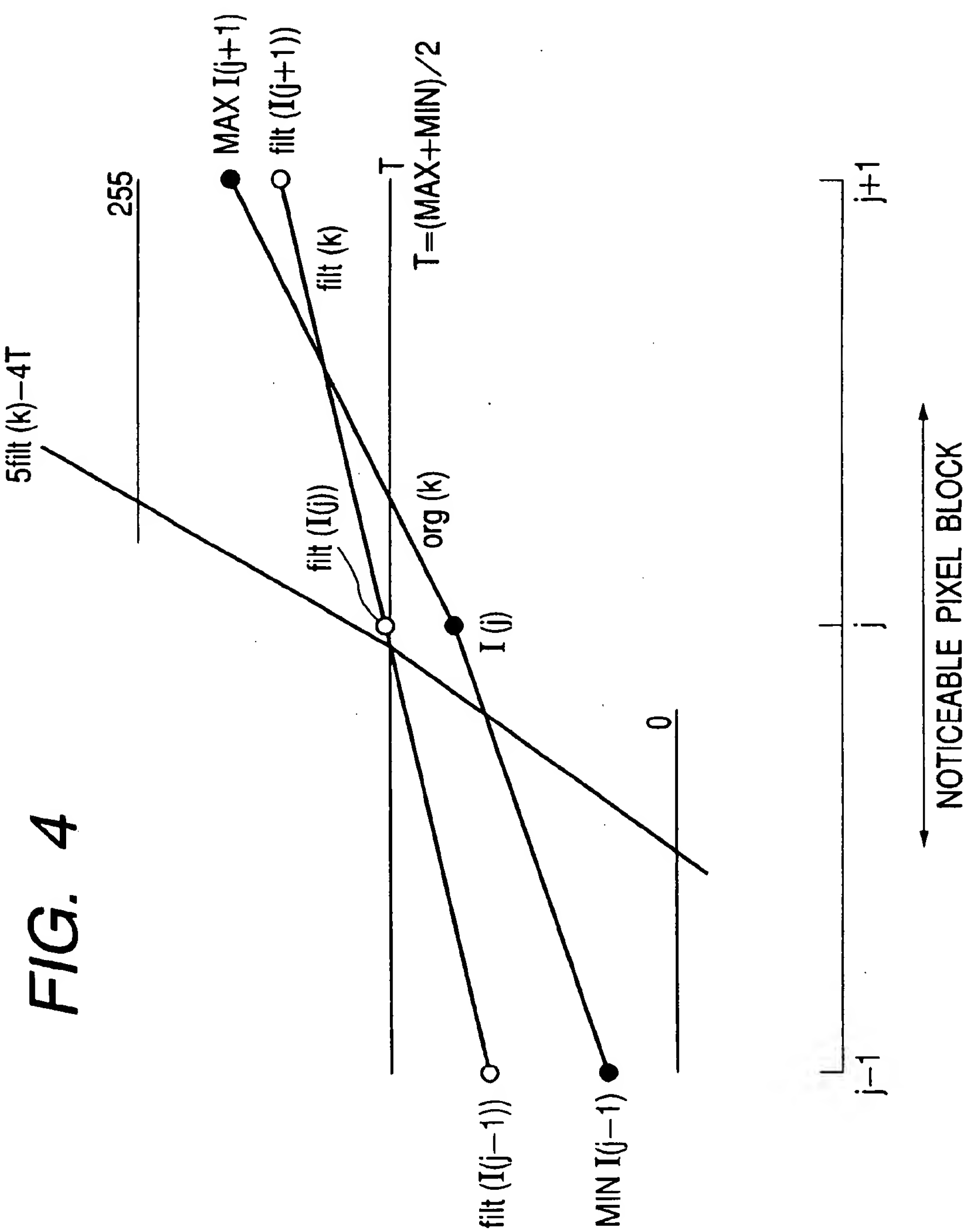

MAX I(j+1)
filt (I(j+1))
T
T=(MAX+MIN)/2
255
filt (k)
5filt (k)−4T
filt (I(j))
org (k)
I (j)
0
filt (I(j−1))
MIN I(j−1)
j−1
j
j+1
NOTICEABLE PIXEL BLOCK

FIG. 5

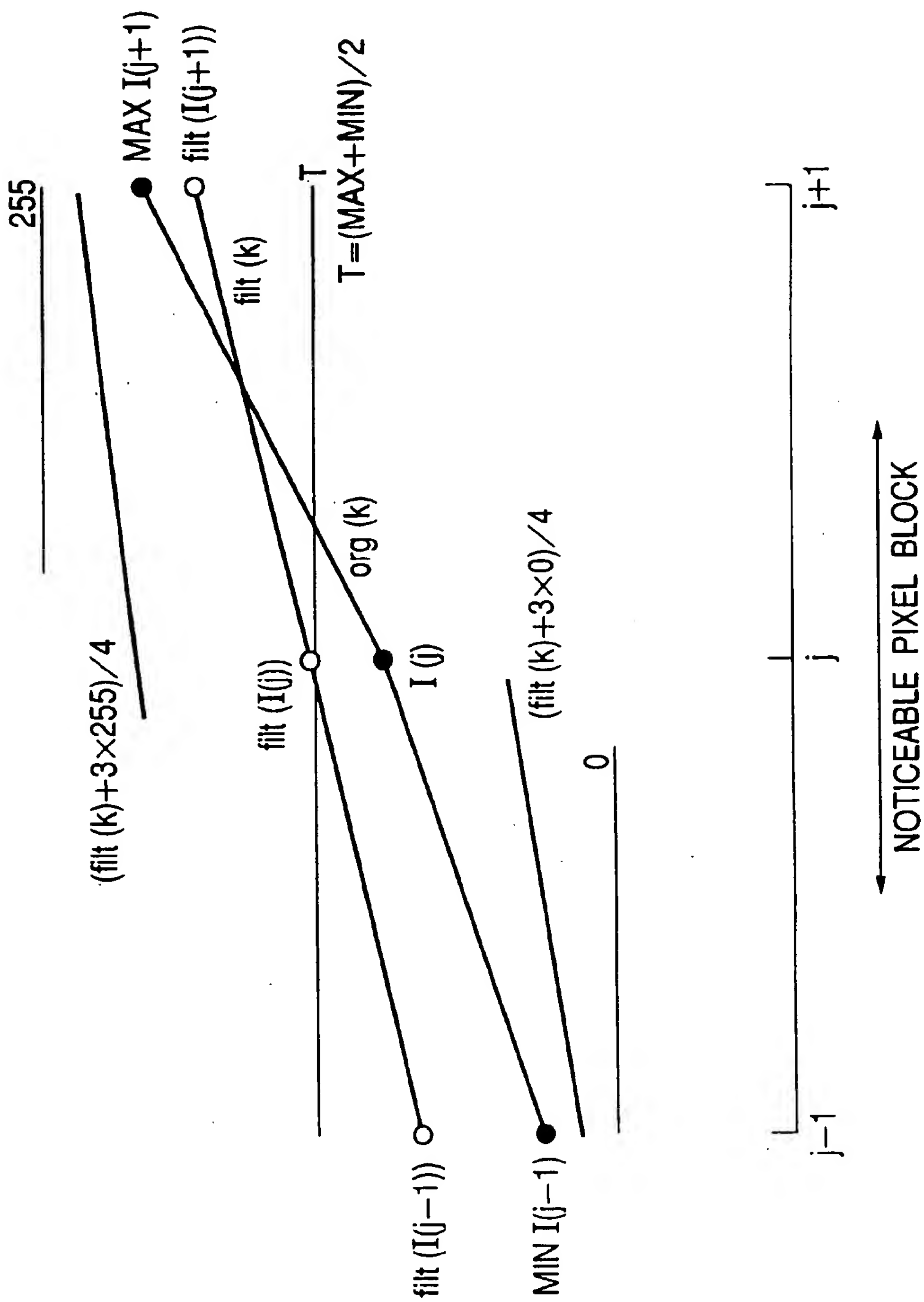

MAX I(j+1)
filt (I(j+1))
T=(MAX+MIN)/2
T
255
filt (k)
org (k)
(filt (k)+3×255)/4
(filt (k)+3×0)/4
filt (I(j))
I (j)
0
filt (I(j−1))
MIN I(j−1)
j+1
j
j−1
NOTICEABLE PIXEL BLOCK

FIG. 6

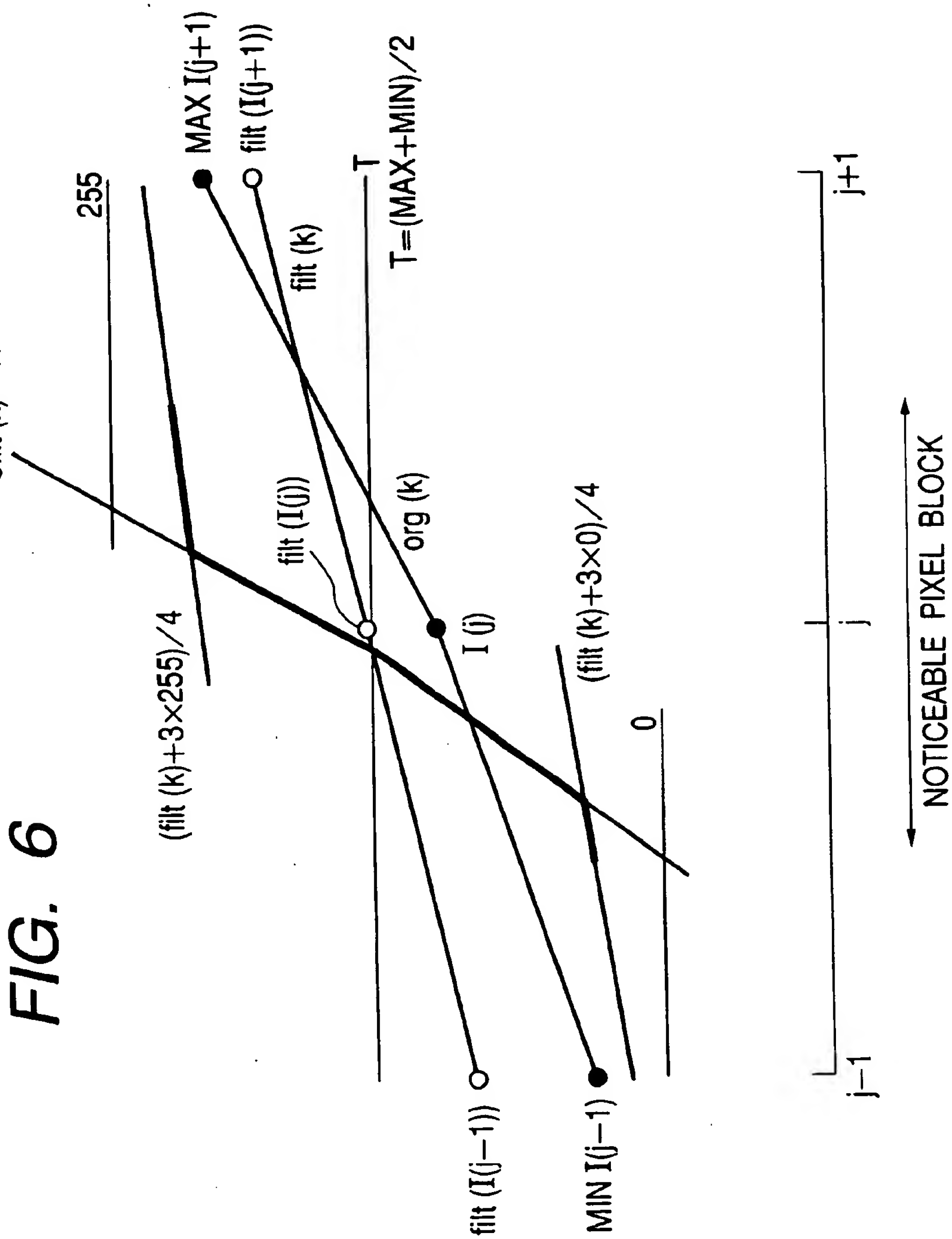
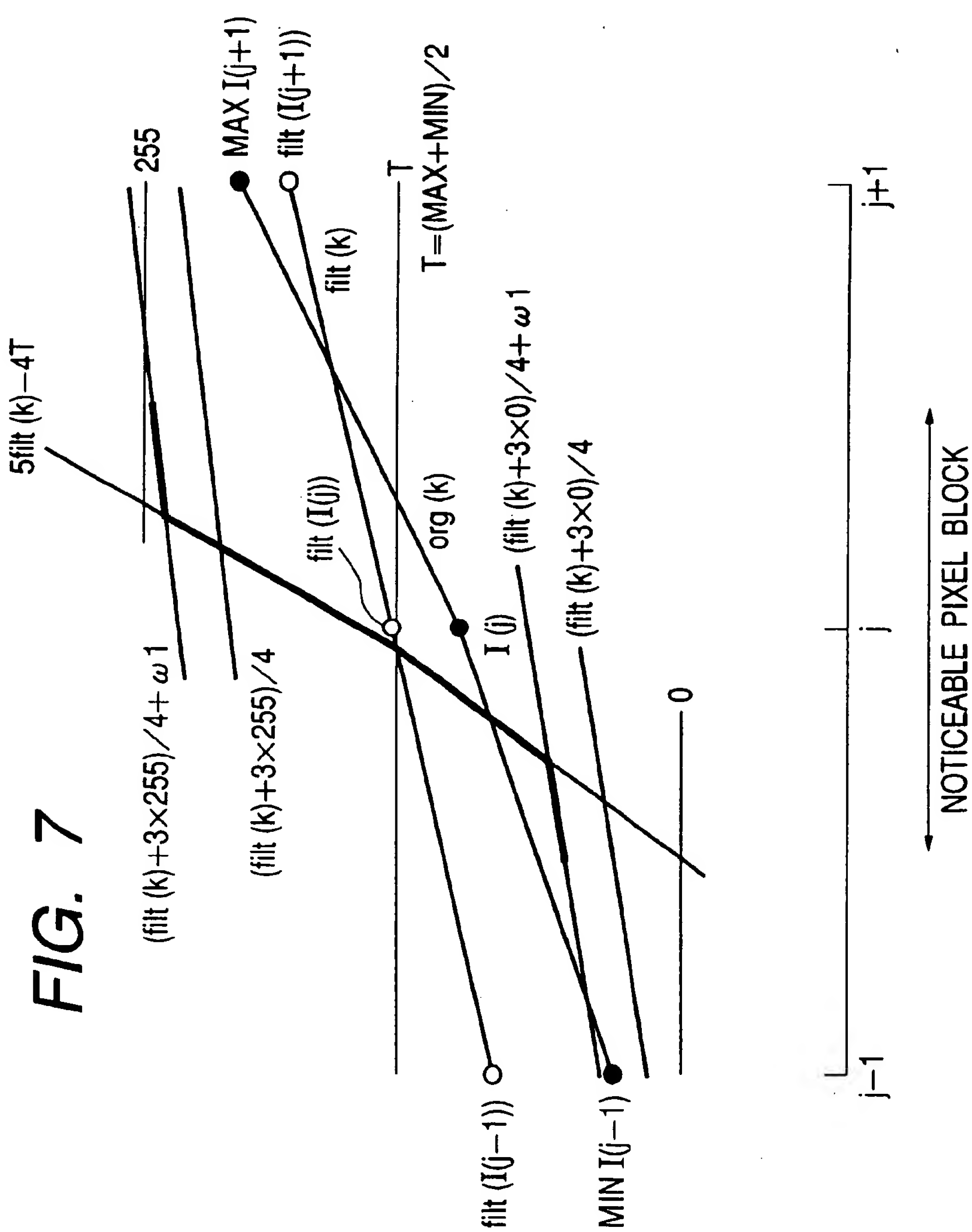

5filt (k)−4T
255
MAX I(j+1)
filt (I(j+1))
T
T=(MAX+MIN)/2
filt (k)
filt (I(j))
org (k)
I (j)
(filt (k)+3×255)/4
(filt (k)+3×0)/4
0
filt (I(j−1))
MIN I(j−1)
j+1
j
j−1
NOTICEABLE PIXEL BLOCK

FIG. 7


5filt (k)−4T
255
MAX I(j+1)
filt (I(j+1))
T
T=(MAX+MIN)/2
filt (k)
org (k)
filt (I(j))
I (j)
(filt (k)+3×0)/4+ω1
(filt (k)+3×0)/4
(filt (k)+3×255)/4+ω1
(filt (k)+3×255)/4
0
filt (I(j−1))
MIN I(j−1)
j−1
j
j+1
NOTICEABLE PIXEL BLOCK

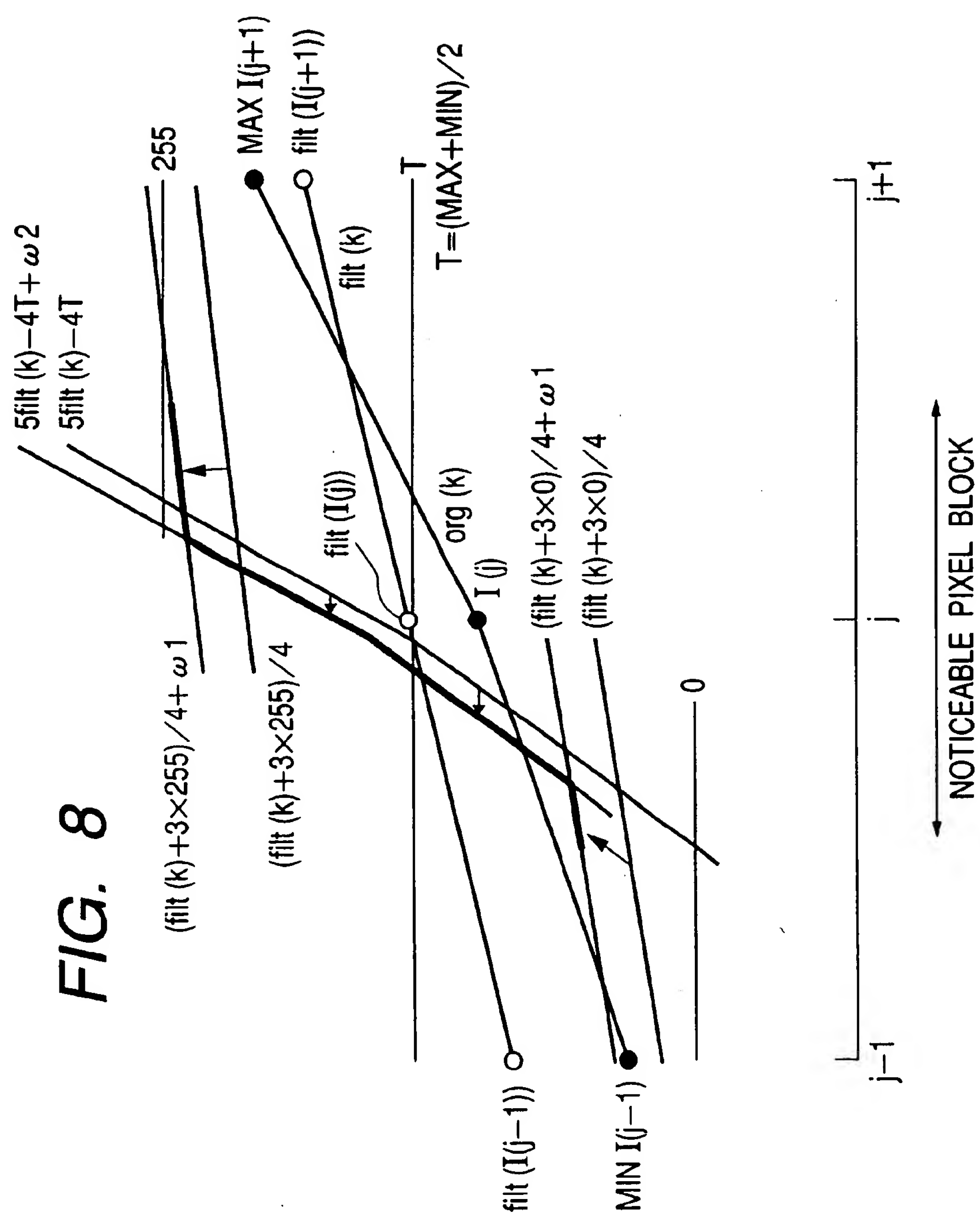
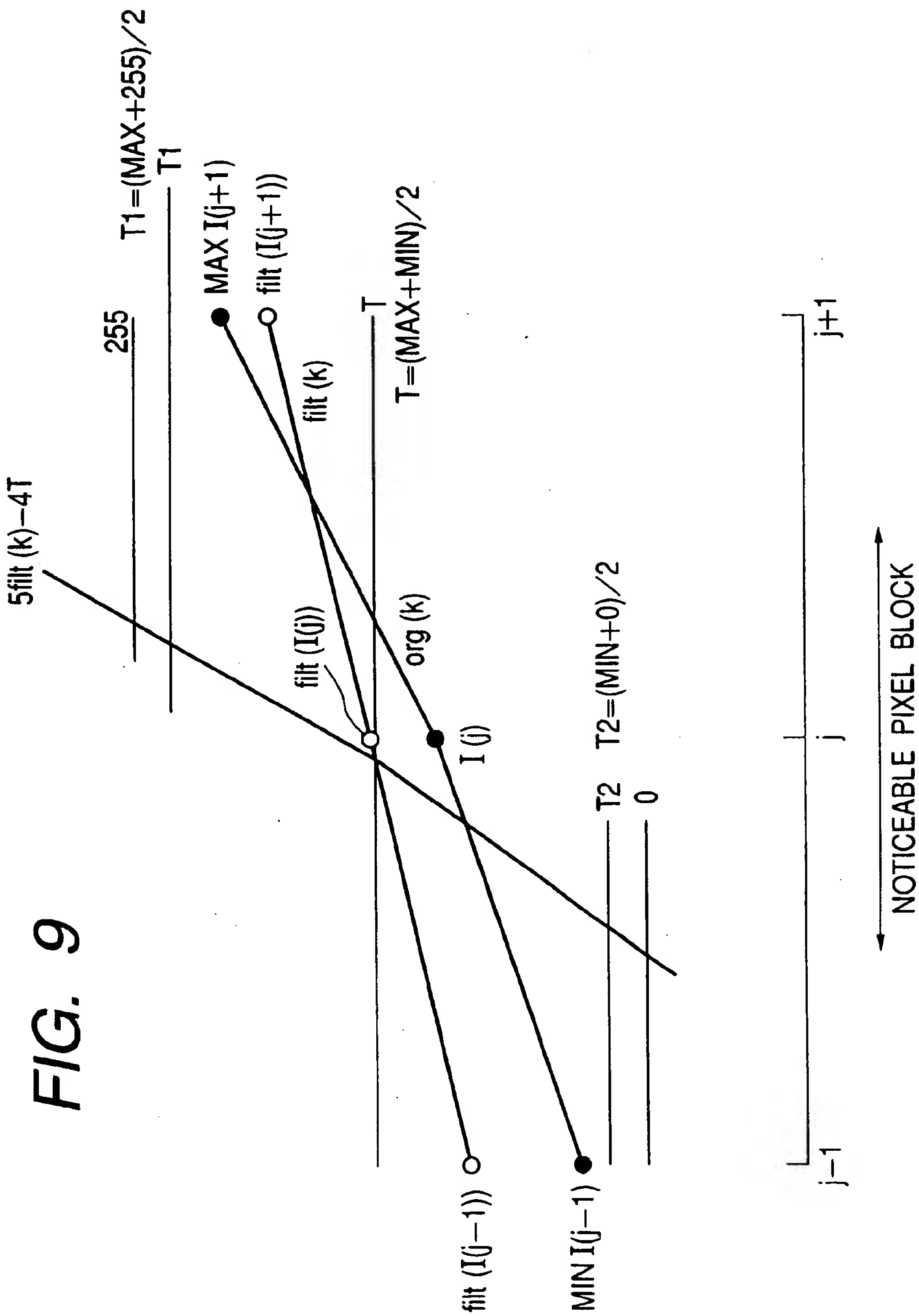

5filt (k)−4T+ω2
5filt (k)−4T
255
MAX I(j+1)
filt (I(j+1))
T
T=(MAX+MIN)/2
filt (k)
filt (I(j))
org (k)
I (j)
(filt (k)+3×0)/4+ω1
(filt (k)+3×0)/4
(filt (k)+3×255)/4+ω1
(filt (k)+3×255)/4
0
filt (I(j−1))
MIN I(j−1)
j+1
j
j−1
NOTICEABLE PIXEL BLOCK

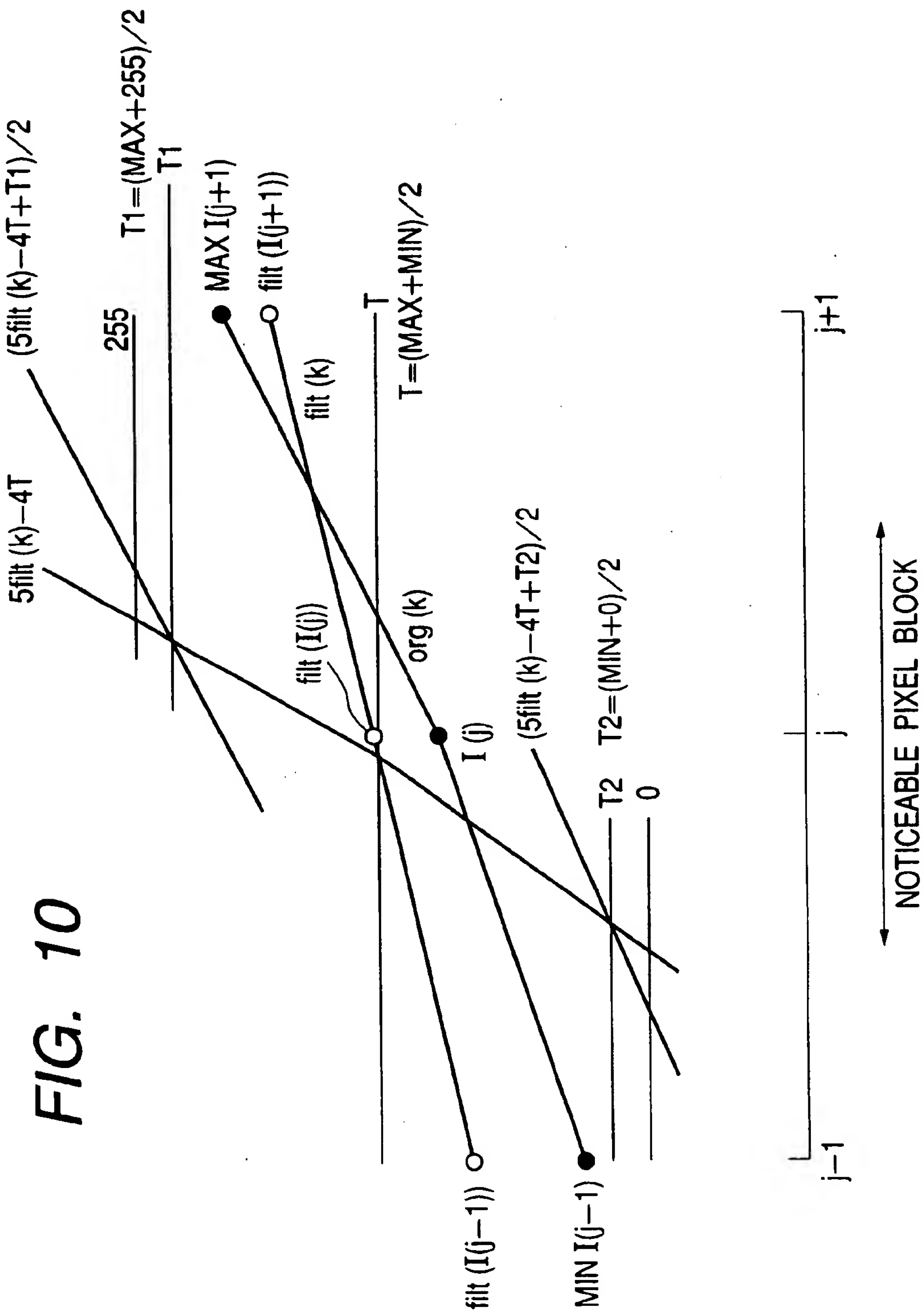
FIG. 8

FIG. 9



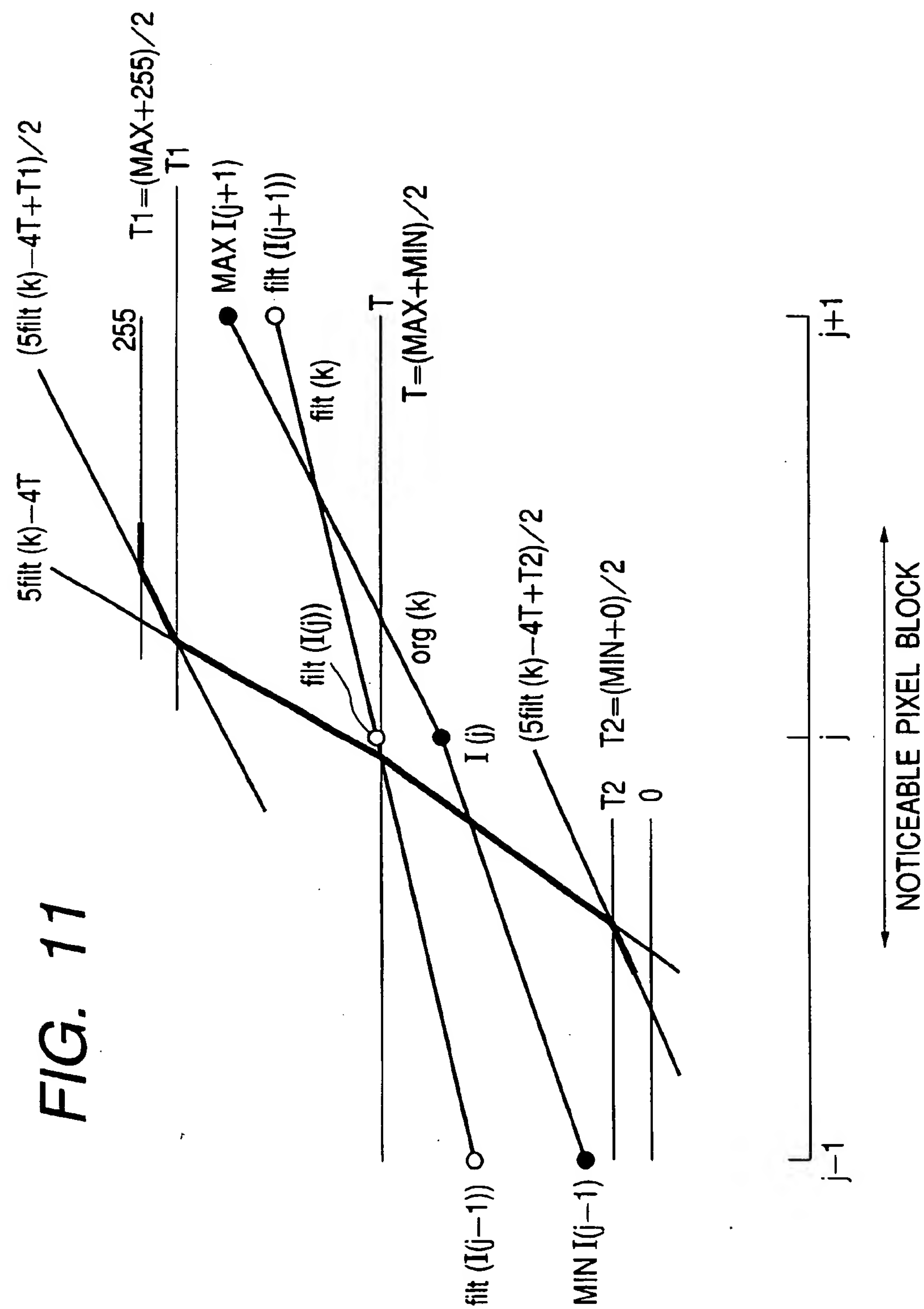
T1=(MAX+255)/2
255
T1
MAX I(j+1)
filt (I(j+1))
T
T=(MAX+MIN)/2
filt (k)
5filt (k)−4T
filt (I(j))
org (k)
I (j)
T2=(MIN+0)/2
T2
0
filt (I(j−1))
MIN I(j−1)
j+1
j
j−1
NOTICEABLE PIXEL BLOCK

FIG. 10



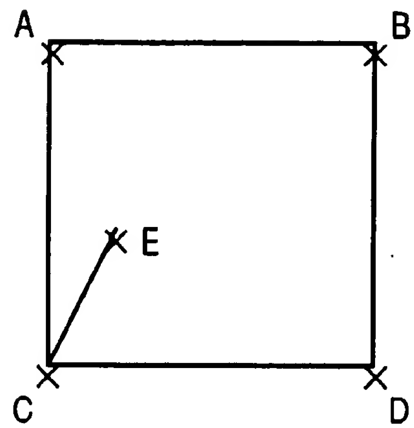
(5filt (k)−4T+T1)/2
T1=(MAX+255)/2
T1
255
MAX I(j+1)
filt (I(j+1))
T
T=(MAX+MIN)/2
filt (k)
5filt (k)−4T
filt (I(j))
org (k)
I (j)
(5filt (k)−4T+T2)/2
T2=(MIN+0)/2
T2
0
filt (I(j−1))
MIN I(j−1)
j−1
j
j+1
NOTICEABLE PIXEL BLOCK

FIG. 11



(5filt (k)−4T+T1)/2
T1=(MAX+255)/2
T1
255
MAX I(j+1)
filt (I(j+1))
T
T=(MAX+MIN)/2
filt (k)
5filt (k)−4T
filt (I(j))
org (k)
I (j)
(5filt (k)−4T+T2)/2
T2=(MIN+0)/2
T2
0
filt (I(j−1))
MIN I(j−1)
j−1
j
j+1
NOTICEABLE PIXEL BLOCK

FIG. 12

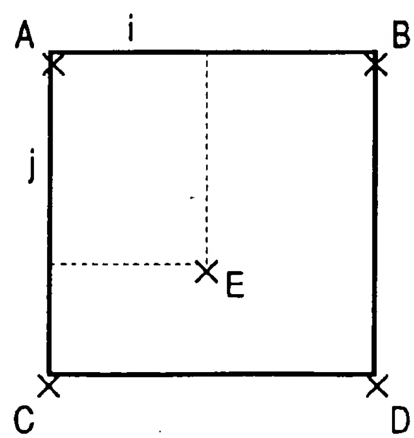


J=MIN (|A−E|, |B−E|, |C−E|, |D−E|)= |X−E|

(J: SHORTEST DISTANCE BETWEEN INTERPOLATION POINT AND OBSERVATION POINT
X: OBSERVATION POINT OF SHORTEST DISTANCE)

INTERPOLATION POINT E=X

FIG. 13



INTERPOLATION POINT E
=(1−i) (1−j) A+i · (1−j) B+j · (1−i) C+ijD

FIG. 14

200	10	10	10	......
10	200	10	10	
10	10	200	10	
10	10	10	200	

⋮

INPUT INFORMATION

FIG. 15

200	200	10	10	10	10	10	10	
200	200	10	10	10	10	10	10	
10	10	200	200	10	10	10	10	
10	10	200	200	10	10	10	10	
10	10	10	10	200	200	10	10	......
10	10	10	10	200	200	10	10	
10	10	10	10	10	10	200	200	
10	10	10	10	10	10	200	200	

⋮

INFORMATION OBTAINED AFTER RESOLUTION CONVERSION BY CLOSEST INTERPOLATION METHOD

<DOUBLE×DOUBLE>

FIG. 16

200	105	10	10	10	10	10	10	
105	105	105	58	10	10	10	10	
10	105	200	105	10	10	10	10	
10	58	105	105	105	58	10	10	
10	10	10	105	200	105	10	10	......
10	10	10	58	105	105	105	58	
10	10	10	10	10	105	200	105	
10	10	10	10	10	58	105	105	

⋮

INFORMATION OBTAINED AFTER RESOLUTION CONVERSION BY COMMON PRIMARY INTERPOLATION METHOD

<DOUBLE×DOUBLE>

IMAGE PROCESS APPARATUS, IMAGE PROCESS METHOD AND COMPUTER-READABLE STORAGE MEDIUM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an image process apparatus, an image process method and a computer-readable storage medium used therein. The apparatus and method are preferably used in an image output apparatus such as a printer or the like for zooming and outputting input image information, or used in a case where low-resolution information is converted into high-resolution information in communication among plural equipments of which resolutions are different from others.

2. Related Background Art

Conventionally, various methods have been proposed as a method to convert inputted low-resolution information into high-resolution information. In such the conventional method, a conversion process method is different according to a kind of target image (e.g., multivalue image having gradation information for each pixel, binary image binarized by pseudo halftoning, binary image binarized based on fixed threshold, character image, or the like).

As a conventional interpolation method, a closest interpolation method shown in FIG. 12 to arrange a pixel value closest to an interpolation point, a common primary interpolation method shown in FIG. 13 to determine a pixel value E by a following calculation according to distances among four points (of which pixel values are assumed to be A, B, C and D respectively) surrounding an interpolation point and the interpolation point, or the like are generally used.

$$E=(1-i)(1-j)A+i\cdot(1-j)B+j\cdot(1-i)C+ijD$$

(in case of distance between pixels="1", distance "i" in lateral direction and distance "j" in longitudinal direction from "A" ($i\leqq 1$, $j\leqq 1$)).

However, such a conventional art has following drawbacks.

Firstly, although the method in FIG. 12 has an advantage in a simple structure, in a case where a target image is used in a natural image or the like, since the pixel value is determined every block to be enlarged, the block is visually emphasized, thereby deteriorating image quality.

Secondly, even in a case where the method is used in a character image, linear image, a CG (computer graphic) or the like, since the same pixel values are sequentially continued every block to be enlarged, an indention phenomenon called as a jaggy phenomenon (or jag) is emphasized especially in an oblique line or the like, thereby deteriorating image quality. FIGS. 14 and 15 show states that the jag appears. FIG. 14 shows an example of input information, and FIG. 15 shows an example of resolution conversion in which the input information of which pixel number are double laterally and longitudinally by the method of FIG. 12. Generally, as a magnification becomes higher, image deterioration becomes serious ("200" and "10" in FIGS. 14 and 15 are pixels values).

On the other hand, the method shown in FIG. 13 is generally used in enlarging the natural image. In this method, the pixel values are averaged to obtain a smoothing image. However, an edge portion or a portion to which sharp image quality is necessary comes to be blurred. Further, in case of an image obtained by scanning a map or the like or a natural image containing a character portion, there is some fear that a reception side can not receive important information because of a blur caused by the interpolation.

FIG. 16 shows image information which is obtained by an interpolation process to double the input image information of FIG. 14 laterally and longitudinally in the method of FIG. 13.

As apparent from FIG. 16, the pixel values do not become uniform not only at a peripheral portion of an oblique line but also at the oblique line itself, whereby a blur appears.

Therefore, in U.S. patent application Ser. No. 311,560 filed on Sep. 23, 1994 (based on Japanese Patent Application Laid-Open Nos. 7-93531, 7-107268 and 7-105359), the applicant of this application proposed such a method as enabling to perform the resolution conversion without generating the blur caused by the interpolation process and generating the jag in forming the high-resolution information from the low-resolution information.

A basic concept of this proposal is based on a method in which components depending on the resolution are eliminated from inputted original information, the number of pixels is increased up to the number corresponding to the output resolution in such a state that the components have been eliminated, and information suitable for a new resolution is speculated and formed in such a state as the number of pixels has been increased. As a means for eliminating dependency of the input resolution, smoothing by an LPF (low-pass filter) and increasing of the pixel number can be realized by a linear interpolation. In a speculation of the high-resolution information, the pixel value to be outputted is calculated by executing different processes to the pixels classified as "1" and the pixels classified as "0" upon simply binarizing the interpolated information.

As proposed in U.S. patent application Ser. No. 715,116 filed on Sep. 23, 1994 (based on Japanese Patent Application Laid-Open No. 9-252400), there is a method for forming a satisfactory edge in which continuity of the pixel values is maintained. In U.S. patent application Ser. No. 715,116, m ($m\geqq 1$) pixels (pixel value at observation point n in m pixels is defined as P(n)) are detected from peripheral pixels of a low-resolution noticeable pixel, and an output value h(k) is calculated based on an interpolation value C(k) at each interpolation point k obtained by interpolating the noticeable pixel for plural pixels, according to a following equation.

$$h(k)=\sum_{n=1}^{m}\alpha(n)P(n)+\beta C(k)$$

($\alpha(n)$ and $\beta(\beta\neq 0)$ are arbitrary coefficients)

However, in any of these relative applications, a basic concept is to form the edge by using maximum and minimum values within a widow on the periphery of the noticeable pixel. That is, these applications apply a method that, in a case where one noticeable pixel is enlarged N times longitudinally and M times laterally, an area within the N×M pixels is assumed to be a part of the edge formation by the maximum and minimum values, and the pixel values of the N×M pixels are newly calculated. According to this method, surely the original image can be converted without unnaturalness as if the high-resolution information is inputted.

However, if use of this method is expanded, there is a case where it is better to provide the image legible for a user even if impression of the original image is highly changed. For example, character information is cited as an example of this case. In a case where a printer is connected to a computer, there are a system in which the computer side having a vector-form font converts resolution into printer resolution,

and a system wherein the print side having a font expands it based on code information sent from the computer side and outputs the data. In this case, since the character information has the vector form, any substantial problem does not occur even if the resolution of input and output sides are different from each other.

However, if it is assumed that the printer is connected to an equipment other than the computer, e.g., an internet television or the like, there is a case where a screen font which is displayed on a television screen and has been anti-alias processed is transmitted to the printer as it is. Further, if it is assumed that the printer is connected to the computer, there are a case where it is necessary to perform screen copy to duplicate information on the screen and a case where it is necessary to tidy and clearly output a character added to the image as a part thereof.

Such a situation is similarly applied to a facsimile apparatus which mainly treats characters and drawings. This is because, in such apparatuses, contrast is reduced and a degree of sharpness in the edge portion becomes dull according to an MTF (modulation transfer function) of an image pickup system for image reading. In these cases, it is unnecessary to generate high-resolution information by reducing the jag and interpolation blur without changing an impression of the inputted low-resolution information, but is necessary to actively convert the inputted low-resolution information into the legible image even if the impression of the low-resolution information is slightly changed. This operation depends on a fact that a property of the character information intended to be transmitted by the user is different from that of the natural image information or the like. That is, in the above equation, although the pixel value of the interpolation point is obtained by a sum of products (i.e., calculation) of the interpolation value and the peripheral pixel value, such terms as contained in the sum of products are insufficient for the calculation. That is, if the contrast of the original image is deteriorated, a high-resolution image exceeding the contrast of the original image can not be formed.

SUMMARY OF THE INVENTION

The present invention has been made in consideration of the above-described conventional problems, and an object thereof is to provide an image process apparatus, an image process method and a computer-readable storage medium used therein. In the apparatus and method, a clear high-resolution image of which contrast is higher than that of input low-resolution information can be obtained without any jag even if the contrast of the input low-resolution information is deteriorated.

Another object of the present invention is to provide an image process apparatus, an image process method and a computer-readable storage medium used therein. In the apparatus and method, an edge angle and an edge central position can be freely designed in case of converting low-resolution information into high-resolution information, thereby enabling to form a satisfactory edge having continuity.

Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the figures thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiment of the invention and, together with the description, serve to explain the principles of the invention.

FIG. 1 is a block diagram showing an embodiment of the present invention;

FIG. 2 is a structural view showing an example of a smoothing filter;

FIG. 3 is a structural view for explaining a high-resolution edge;

FIG. 4 is a structural view for explaining the high-resolution edge;

FIG. 5 is a structural view for explaining the high-resolution edge;

FIG. 6 is a structural view for explaining the high-resolution edge;

FIG. 7 is a structural view for explaining the high-resolution edge;

FIG. 8 is a structural view for explaining the high-resolution edge;

FIG. 9 is a structural view for explaining the high-resolution edge;

FIG. 10 is a structural view for explaining the high-resolution edge;

FIG. 11 is a structural view for explaining the high-resolution edge;

FIG. 12 is a structural view showing a conventional closest interpolation method;

FIG. 13 is a structural view showing a conventional common primary interpolation method;

FIG. 14 is a structural view showing an example of input information;

FIG. 15 is a structural view showing a processing example according to the method shown in FIG. 12; and

FIG. 16 is a structural view showing a processing example according to the method shown in FIG. 13.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred embodiment of the present invention will now be described in detail in accordance with the accompanying drawings.

FIG. 1 is a main block diagram showing the embodiment of the present invention. It is effective to provide an image process apparatus according to the present embodiment, within an image output apparatus such as a printer mainly connected to a computer, a printer connected to an equipment (e.g., internet television main body, set-top box of internet television or the like) other than the computer, and a video printer for inputting a video signal, or the like. However, the apparatus according to the present embodiment can be involved as an application software provided in an image process apparatus other than the image output apparatus, a facsimile apparatus or a host computer, or can be involved as a printer driver software to be used to output data to the printer.

Subsequently, structure and operation procedure in the present embodiment will be described with reference to the block diagram in FIG. 1. In the present embodiment, an example for converting inputted image information into information of which pixels number is enlarged N times longitudinally and M times laterally will be described.

In FIG. 1, numeral 100 denotes an input terminal to which low-resolution image information is inputted. The low-resolution information is stored and held for several lines by

a line buffer **101**. A process of window unit depending on plural peripheral pixels containing a noticeable pixel is executed based on the image information of several lines. Numeral **102** denotes a maximum/minimum value detection unit (to be referred as MAX/MIN detection unit hereinafter) which detects a maximum value and a minimum value from the image information within the window.

Numeral **103** denotes a smoothing unit which performs a filtering process to each of pixels within the window by using an LPF (low-pass filter). FIG. **2** shows an example of a smoothing filter. A high frequency component is interrupted by obtaining an average of nine pixels containing the noticeable pixel surrounded by other peripheral pixels.

In FIG. **1**, numeral **104** denotes an interpolation unit. Pixels surrounded by original sampling points are filled around the noticeable pixel depending on a common primary interpolation process (to be referred as linear interpolation process hereinafter) such that the interpolation unit generates interpolation information at an interpolation point corresponded to longitudinal N pixels×lateral M pixels. Since the linear interpolation process is described in the conventional example shown in FIG. **12**, description thereof will be omitted. As pixel values of the peripheral pixels used in a sum of products (i.e., calculation) of the linear interpolation, filtered pixel values are used. For example, in a case where the filter of 3×3 pixels shown in FIG. **2** is used, if a capacity of the line buffer **101** is provided for five lines, it becomes possible to perform the filtering process not only to the noticeable pixel but also to the peripheral eight pixels used in the sum of products.

Numeral **105** denotes an arithmetic unit. Two kinds of fixed signal values and an offset value in addition to three kinds of signal values such as the maximum value, the minimum value detected by the detection unit **102** and an interpolation value P(i,j) ($0 \leqq i<N$, $0 \leqq j<M$) at the interpolation point (i,j) calculated in the interpolation unit **104** are inputted to the unit **105**. Then, the unit **105** calculates a new output value by performing a predetermined calculation based on the inputted six kinds of signal values. If the input signal is a digital signal consists of Z bits/pixel information for one color, an image signal can take 2^z values within a range from "0" to "2^z-1". In the present embodiment, the fixed input values to be inputted to the unit **105** are defined as the two kinds of values "0" and "2^z-1". In this case, the offset value may be a value previously and experimentally obtained.

The arithmetic unit **105** obtains the sum of products, and calculates an output value D(i,j) at the interpolation point according to a following equation.

$$D(i,j)=a\times MAX+b\times MIN+c\times P(i,j)+d\times(2^z-1)+e\times 0+\omega$$

(a, b, c, d and e are predetermined coefficients, and ω is arbitrary offset value)

The above output-point calculation is executed M×N times, generation of high-resolution information for one noticeable pixel, and then the calculated result is outputted to an output terminal **106**.

In the above structure, the high-resolution information is generated from the low-resolution information according to the following procedure.

FIG. **3** is a view for simply explaining an interpolation calculation according to the present embodiment in one-dimensional field. In FIG. **3**, a lateral axis direction denotes one-dimensional coordinate space, wherein the noticeable pixel is defined as j and the front and rear peripheral pixels are defined as (j−1) and (j+1) respectively. The noticeable pixel j and the plural pixels expanded from the pixel j collectively constitute a noticeable pixel block, and the information is generated based on this block. That is, a pixel value corresponding to the noticeable pixel block is generated from one noticeable pixel. A longitudinal axis direction indicates a depth direction of the pixel value, and points indicated by small black circles (referred as black points hereinafter) represent pixel values of original information of the noticeable pixel and the peripheral pixels. These black points and respectively defined as values I(j), I(j−1) and I(j+1).

It is assumed that an edge portion is formed by the peripheral pixels and the noticeable pixel is being inside the edge portion. A line drawn between the pixel values of the original information of the noticeable pixels and the peripheral pixels based on the linear interpolation process is defined as a line org(k) (k is coordinate value based on spatial interpolation point). In the drawing, in order to simplify the explanation, the line is drawn in analog manner. In order to form a high-resolution edge without any jag when the high-resolution information is generated, it is inappropriate to depend on the inputted original information. That is, at the edge portion to be formed, it is inappropriate to depend on an observation point indicated by the black point and the line org(k) formed in the linear interpolation process. Therefore, the original information is smoothed by the LPF. Points indicated by small white circles (referred as white points hereinafter) represent pixel values of the pixel obtained by smoothing the noticeable pixel and the peripheral pixel. The three white points are respectively defined as values filt(I(j)), filt(I(j−1)) and filt(I(j+1)).

A line drawn between the smoothed white points in the linear interpolation is defined as a line filt(k). The high-resolution edge is formed based on the line filt(k). The line filt(k) becomes a locus of density change in which a contrast is decreased in the depth direction as compared with that of the line org(k). A straight line T represents a mean value of a maximum value (MAX) and a minimum value (MIN) of the peripheral pixels. That is, a following equation is given.

$$T=(MAX+MIN)/2 \tag{1}$$

In the present embodiment, formation of a new high-resolution edge is realized by a sequential locus by deforming a density change line represented by the value filt(k). As described above, the density change line represented by the line filt(k) becomes such a line as the contrast is more decreased as compared with that of the line org(k). Therefore, the line is deformed to have sharp inclination around the edge portion. A deformation degree of the density change line is calculated based on extrapolation to be executed to the density change line represented by the line filt(k) and the straight line T.

That is, if a change line used for sharply converting the inclination is defined as h(k), a following equation is given.

$$h(k)=a\times filt(k)-(a-1)\times T \tag{2}$$

According to the equations (1) and (2), a following equation is given.

$$h(k)=a\times filt(k)-(a-1)\times(MAX+MIN)/2 \tag{3}$$

If the equation (3) is rewritten, a following equation is given.

$$h(k)=a\times filt(k)+(-(a-1)/2)MAX+(-(a-1)/2)MIN \tag{4}$$

Generally, the inclination of edge can be sharped by a following equation.

$$h(k)=a\times filt(k)+b\times MAX+c\times MIN \tag{5}$$

FIG. 3 shows the density change line in four cases of h(k) (a=2, 3, 4 and 5). In every case, the inclination of the line filt(k) becomes sharp around an intersection point of the filt(k) and the straight line T. In other words, a spatial coordinate position at the center of the edge is obtained by changing the line filt(k) by an angle of the fixed density change.

FIG. 4 shows a state to form the edge in case of a=5. Naturally, since the change line represented by h(k) increases the contrast, it is necessary to exert limitation according to the magnification of the density value. A critical point of the limitation corresponds to a dynamic range of a signal. That is, in the present embodiment, the critical point is selectable within a range from "0" to "2^z-1". Here, it is assumed that Z is "8", i.e., an input signal has information of 8 bits/pixel for one color, the dynamic range is selectable within the range from "0" to "255".

The present embodiment is different from Japanese Patent Application Laid-Open No. 9-252400 which is the prior application of the same applicant as that in the present application, in the point that the high-resolution information in which the edge contrast is more increased is generated. In FIG. 4, the MAX and MIN values are not used, but "0" and "255" respectively being maximum and minimum values capable of being taken by the input signal are used to calculate following equations.

$$h1(k)=(d\times 255+(1-d)\times filt(k)) \tag{6}$$

$$h2(k)=(e\times 0+(1-e)\times filt(k)) \tag{7}$$

Each of the equations (6) and (7) represents a sum of products of the fixed signal value and the interpolation value.

A locus of the density change line in case of d="¾" is shown in FIG. 5.

An output value D(k) is selected according to the three kinds of change lines obtained by the equations (5), (6) and (7), as follows.

$$D(k)=h1(k)\ (\text{when } h(k)\geqq h1(k))$$

$$D(k)=h(k)\ (\text{when } h1(k)>h(k)\geqq h2(k))$$

$$D(k)=h2(k)\ (\text{when } h2(k)>h(k)) \tag{8}$$

The above state is shown in FIG. 6. A portion of thick solid line corresponds to the high-resolution information D(k) formed based on the noticeable pixels block. As apparent from the thick solid line in FIG. 6, the locus of the density change line more increasing the contrast can be formed even at the maximum and minimum value portions of which contrasts have been reduced. Moreover, the inclination can be changed sharply at the high-resolution edge portion and changed gently at the portion spatially separated from the edge center. Even if the angle is gentle, since the line has inclination, the significantly smoother image can be formed as compared with the case of clipping the contrast at a fixed value. Moreover, the changes of these inclinations can be realized with continuity. That is, when the above three kinds of density change lines are designed to be optimal for a system which executes the above process, the locus of high-resolution edge can be freely formed.

FIG. 7 indicates a state that an offset value ω1 is added to the equations (6) and (7). That is, in order to obtain a more legible image such as a character or the like, the density of the character can be changed by changing not only an edge angle but also a point at which the density change line is non-linearly changed.

FIG. 8 indicates a state that the offset value ω1 is added to the equations (6) and (7) and an offset value ω2 is added to the equation (5). Since the edge central position tends to be shifted in the image such as the character or the like, it is possible in this image to control thickening and thinning of the character. When the density value exceeds the dynamic range of the signal upon adding the offset value, such the value is of course clipped.

Also, the equations (6) and (7) may be provided as the sum of products of the line org(k) and the fixed value instead of the sum of products of the line filt(k) and the fixed value. Since the line filt(k) is the density change line from which resolution dependency of the inputted original information has been eliminated, the line filt(k) is very important to form the edge central position. However, the edge central position is formed based on the equation (5), and the lines represented by the equations (6) and (7) are spatially separated from the edge center. Therefore, it is very effective to use also the line org(k) of which the contrast is higher than that of the line filt(k).

In the present embodiment, there is no problem even in case of MAX="255" or MIN="0". On the contrary, in a case where MAX and MIN exist within an intermediate level, the contrast of the edge is unnecessarily increased. For this reason, as a condition to execute this process, such a condition as the contrast of MAX−MIN is higher than or equal to a certain set threshold, or MAX is higher than or equal to a certain set value and MIN is lower than or equal to this value is required. It is effective to adopt such a specification as executing the process only when the inputted noticeable pixel is judged as an artificial image such as a character portion or the like by adding a judgement condition to judge if the inputted noticeable pixel is a character portion or a part of natural image.

As above, the density change line based on the sum of products of the interpolation value and the peripheral pixels and the locus according to the switching of the density change line based on the sum of products of the interpolation value and the fixed value have been explained. Subsequently, an example to calculate the density change line based on the sum of products of the interpolation value, the peripheral pixels and the fixed value will be described.

In FIG. 9, T1 indicates a mean value of MAX and "255", and T2 indicates a mean value of MIN and "0".

$$T1=(MAX+255)/2 \tag{9}$$

$$T2=(MIN+0)/2 \tag{10}$$

The interpolation with each straight line represented by the mean values T1 and T2 and the line h(k) obtained by the equation (5) is calculated. As shown in FIG. 10, if it is assumed that h(k)=5filt(k)−4T and that each coefficient concerning the interpolation of the values T1 and T2 and the line h(k) is ½, following equations are given.

$$h3(k)=(5filt(k)-4T+T1)/2 \tag{11}$$

$$h4(k)=(5filt(k)-4T+T1)/2 \tag{12}$$

If the equations (11) and (12) are rearranged by using the equations (1), (9) and (10), following equations are given.

$$h3(k)=(-3/4)\times MAX-MIN+(5/2)\times filt(k)+(1/4)\times 255 \tag{13}$$

$$h4(k)=(-3/4)\times MAX-MIN+(5/2)\times filt(k)+(1/4)\times 0 \tag{14}$$

Subsequently, the output value D(k) is selected depending on the three kinds of change lines obtained by the equations (5), (13) and (14), as follows.

$$D(k)=h3(k) \text{ (when } h(k)\geqq h3(k))$$

$$D(k)=h(k) \text{ (when } h3(k)>h(k)h4(k))$$

$$D(k)=h4(k) \text{ (when } h4(k)>h(k)) \tag{15}$$

The above state is shown in FIG. 11. A portion of thick line corresponds to the high-resolution information D(k) formed based on the noticeable pixel block. Of course, the change lines exceeding the values "255" and "0" are clipped.

An advantage of this change line is to make angle controlling easy. That is, as apparent from the mean values T1 and T2 shown in FIG. 11, the density at which the inclination of the change line is changed can be previously set. In the equations (9) and (10), although the examples that T1 is the means value of MAX and "255" and T2 is the mean value of MIN and "0" are given, of course, values other than these values can be freely set. As mentioned above, the object of the present invention is to change the inclination sharply at the edge portion and gently at the portion spatially separated from the edge center. In this case, if the density to gently changing the inclination can be previously set, a degree of freedom in image designing can be widened. Of course, it is possible to set a larger number of densities for change than the two kinds of values T1 and T2.

In this case, the inclination can be gradually changed from sharp one to gentle one. The gentle inclination can be realized by gradually changing a coefficient in interpolating the change line h(k). That is, if the line which is calculated by the interpolation and extrapolation of the line org(k) or the line filt(k) being the interpolation value and the function (i.e., peripheral pixel value or fixed value) not depending on the interpolation address k is managed as the locus of the density line, the edge angle can be easily and freely changed from sharp one to gentle one as maintaining continuity.

As above, it has been explained the case where the one-dimensional and high-resolution edge is formed. However, the above situation can be of course expanded to a two-dimensional field. Further, a window for detecting MAX and MIN, a window for performing the filtering and a window used in the interpolation may have the same size or the different sizes. Of course, the process may be executed in such a manner as decreasing the times of the sum of products by gathering the interpolation calculation and the filtering calculation together. Also, an interpolation method other than the linear interpolation process may be used.

Although the smoothing has been mainly explained as the filtering process, there is some fear that important information is deleted by executing the smoothing. In such a case, it is possible to initially use a different filter. Also, it is possible to evaluate a characteristic amount of the image and dynamically change the filter based on this evaluation.

As to the detection process for detecting the pixel value from the peripheral pixels, an example to execute the process by extracting the two kinds of values MAX and MIN has been explained. However, of course, the pixel values are not limited to them. Namely, pixels having other value such as an intermediate value within the window or the like may be used. Further, the number of pixels to be extracted is not limited to two. For example, MAX and MIN are detected within each of two kinds of windows of which sizes are made different from each other. As a result, it is also possible to form the density change line in accordance with a function using the total four kinds of values detected.

As the fixed value used in the sum of products, the two kinds of values "0" and "2^z-1" being the maximum and minimum values within the dynamic range of the input signal have been used. However, the values are not limited to them, and two or more kinds of fixed values may be used. That is, if each pixel value of the peripheral pixels to be extracted is defined as P(n) and the fixed value to be used in the calculation is defined as Q(s), a following equation is given.

$$h(k)=a\times filt(k)+b1\times P(1)+b2\times P(2)+b3\times P(3)+b4\times P(4)+\ldots+c1\times Q(1)+c2\times Q(2)+c3\times Q(3)+c4\times Q(4)+\ldots \tag{16}$$

Generally, the m peripheral pixels are extracted and the t kinds of fixed values are used, a following equation is given.

$$h(k)=a\times filt(k)+\sum_{n=1}^{m}\alpha(n)P(n)+\sum_{s=1}^{t}\gamma(s)Q(s) \tag{17}$$

Even in this case, there are plural combinations of a, $\alpha(n)$, P(n), $\gamma(s)$ and Q(s), and the output value D(k) can be selected from the calculated the plural lines h(k).

As described above, in a case where the filtering is not limited to the smoothing, the. interpolation value at the interpolation point k is described as C(k), and if the arbitrary offset value ω is added, the equation (17) is generally described as follows.

$$h(k)=\sum_{n=1}^{m}\alpha(n)P(n)+\beta C(k)+\sum_{s=1}^{t}\gamma(s)Q(s)+\omega \tag{18}$$

($\alpha(n)$, $\beta(\beta\neq 0)$ and $\gamma(s)$ are arbitrary coefficients, Q(s) is signal value within range capable of being taken by pixel value, ω is arbitrary value, m satisfies $m\geqq 1$, and t satisfies $t\geqq 1$)

$$\sum_{n=1}^{m}\alpha(n)+\beta+\sum_{s=1}^{t}\gamma(s)=1 \tag{19}$$

The h(k) satisfying the equations (18) and (19) is represented by the addition of a function depending on the interpolation point and a function not depending on the interpolation point. The functions not depending on the interpolation point can be classified into the function depending on the peripheral pixels and the function depending on the fixed value not concerning the peripheral pixels.

In the conventional example shown in FIG. 12, the function does not depend on the interpolation point because neighboring observation points are replaced. That is, in case of replacing the closest observation point, the pixel values within the noticeable pixel block around the observation point being the noticeable point have a fixed value irrespective of the interpolation point. Further, in FIG. 13, the function depends on the interpolation point. Also, the function depends on the interpolation point in a conventional high-order interpolation calculation. However, in order to form the high-resolution information, if some information formation such as speculation of the edge portion, a change of the contrast inclination or the like is not performed, the image conversion can not be performed in high image quality.

The concept of the present invention can be found in changing the high-resolution information which does not exist in the original information. As described above, by the

change line which satisfies the equations (18) and (19), it is possible to realize the satisfactory conversion in which the change of edge position, the change of contrast inclination and the like can be freely set. Further, since the above equations contain the terms of function based on the fixed value not relative to the peripheral pixel, controlling is possible to arbitrarily change the density and vary the line width. Therefore, even if the original image has been deteriorated, further satisfactory image quality can be obtained.

As described above, according to the present invention, in the case where the inputted low-resolution information is converted into the high-resolution information, it is possible to realize the conversion which does not depend on the low resolution of the original information and can produce the jagless image of which image quality is high.

In the case where the image formation apparatus to which the present invention has been applied is connected to the internet television, the computer and the like, if screen copy for copying the information on the screen is performed, if the character contained in the image as the part thereof should be excellently outputted, and even if the contrast of the input information has been deteriorated due to the MTF of the image pickup system of the facsimile apparatus or the like mainly managing the character, the drawing and the like, it is possible to form the image having higher resolution than the contrast of the input information. Furthermore, in the present invention, since the new edge angle and the edge central position can be freely designed, it is possible to form the satisfactory edge having continuity.

Therefore, according to the present invention, since the clear jagless image can be outputted to the user who reads this image, it is possible to provide products such as a printer, a video printer and the like to which a high-quality output image can be expected even based on an original image of which information quantity is low.

In the present invention, in addition to the image formation apparatus which is integrally or separately provided as an image output terminal of an information process equipment such as a computer or the like, a copy machine combined with a reader or the like and a facsimile apparatus having a transmission/reception function may be used.

Also, the present invention may be applied to a system structured by plural devices such as a host computer, an interface equipment, a reader, a printer and the like. Further, the present invention may be applied to an individual unit such as a copy machine, a facsimile apparatus or the like.

Also, the present invention may be applied to a case where a storage medium recording therein software program codes to realize the functions of the above embodiment is supplied to a system or an apparatus, and a computer (CPU or MPU) of this system or apparatus reads the program codes stored in the medium to execute them.

In this case, the program codes themselves read from the storage medium realize the functions of the above embodiment, and the storage medium storing therein the program codes constitutes the present invention. As the storage medium for supplying the program codes, e.g., a floppy disk, a hard disk, an optical disk, a magneto-optical disk, a CD-ROM, a CD-R, a magnetic tape, a non-volatile memory card, a ROM or the like can be used.

It is apparently understood that the present invention incorporates not only a case where the functions of the above embodiment are realized by executing the program codes read by the computer, but also a case where an OS (operating system) operating on the computer performs a part or all of the actual process based on instructions of the program codes, and thus the functions of the above embodiment are realized by such the process.

Further, it is apparently understood that the present invention also incorporates a case where the program codes read from the storage medium are stored into a memory provided for a function expansion board of a computer or a function expansion unit connected to a computer and, after that, a CPU or the like provided for the function expansion board or function expansion unit executes a part or all of the actual process based on instructions of the program codes, and the functions of the above embodiment are realized by the process.

As many apparently widely different embodiments of the present invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof expect as defined in the appended claims.

What is claimed is:

1. An image process apparatus for converting low-resolution information to high-resolution information, comprising:

input means for inputting the low-resolution information;

detection means for detecting information of m ($m \geq 1$) pixels from the low-resolution information of a noticeable pixel inputted by said input means and its plural peripheral pixels;

conversion means for converting the low-resolution information of the noticeable pixel inputted by said input means, into interpolation information of plural pixels; and

calculation means for calculating the high-resolution information on the basis of an arbitrary value not concerning the information of the m pixels detected by said detection means, the interpolation information converted by said conversion means, and the inputted low-resolution information.

2. An apparatus according to claim 1, further comprising smoothing means for smoothing the inputted low-resolution information, and

wherein said conversion means converts the information of the noticeable pixel into the interpolation information of the plural pixels based on the information smoothed by said smoothing means.

3. An apparatus according to claim 1, wherein the value m is "2", and said detection means detects maximum and minimum values from the low-resolution information of the inputted noticeable pixel and the plural peripheral pixels.

4. An image processing method for converting low-resolution information into high-resolution information, comprising the steps of:

detecting information of m ($m \geq 1$) pixels from the low-resolution information of an inputted noticeable pixel and its plural peripheral pixels;

converting the low-resolution information of the inputted noticeable pixel into interpolation information of plural pixels; and

calculating the high-resolution information based on an arbitrary value not concerning the information of the detected m pixels, the interpolation information obtained by said conversion step, and the inputted low-resolution information.

5. A method according to claim 4, wherein the inputted low-resolution information is smoothed, and said conversion step converts the information of the noticeable pixel into the interpolation information of the plural pixels based on the smoothed information.

6. A method according to claim 4, the value m is "2", and said detection step detects maximum and minimum values from the low-resolution information of the inputted noticeable pixel and the plural peripheral pixels.

7. An image process apparatus comprising:

detection means for detecting m ($m \geqq 1$) pixels from peripheral pixels of a noticeable pixel in input image information (a pixel value at an observation point among m points is defined as P(n));

interpolation means for interpolating the noticeable pixel to plural pixels based on the input image information; and

calculation means for calculating an output value h(k) based on an interpolation value C(k) interpolated at each interpolation point k, according to a following equation,

$$h(k) = \sum_{n=1}^{m} \alpha(n)P(n) + \beta C(k) + \sum_{s=1}^{t} \gamma(s)Q(s) + \omega$$

($\alpha(n)$, $\beta(\beta \neq 0)$ and $\gamma(s)$ are arbitrary coefficients, Q(s) is an arbitrary signal value within a range capable of being taken by a pixel value, ω is an arbitrary value, and t satisfies $t \geqq 1$).

8. An apparatus according to claim 7, further comprising smoothing means for smoothing the input image information, and

wherein said interpolation means interpolates the noticeable pixel to the plural pixels based on the smoothed information.

9. An apparatus according to claim 7, wherein a relation of α(n), β and γ(s) satisfies

$$\sum_{n=1}^{m} \alpha(n) + \beta + \sum_{s=1}^{t} \gamma(s) = 1.$$

10. An apparatus according to claim 7, wherein there are plural combinations of α(n), P(n), β, γ(s) and Q(s), and the most suitable value is selected as an output value D(k) by comparing values of the plural calculated h(k) with others.

11. An apparatus according to claim 7, wherein α(1) and α(2) are respectively maximum and minimum values within the peripheral pixels when m satisfies m=2.

12. An apparatus according to claim 7, wherein, when the input image information corresponds to Z bits/pixel for one color and t satisfies t=2, γ(1) and γ(2) are respectively "0" and "2^z-1".

13. An image processing method comprising:

a detection step of detecting m ($m \geqq 1$) pixels from peripheral pixels of a noticeable pixel in input image information (a pixel value at an observation point among m points is defined as P(n));

an interpolation step of interpolating the noticeable pixel to plural pixels based on the input image information; and

a calculation step of calculating an output value h(k) based on an interpolation value C(k) interpolated at each interpolation point k, according to an following equation,

$$h(k) = \sum_{n=1}^{m} \alpha(n)P(n) + \beta C(k) + \sum_{s=1}^{t} \gamma(s)Q(s) + \omega$$

($\alpha(n)$, $\beta(\beta \neq 0)$ and $\gamma(s)$ are arbitrary coefficients, Q(s) is an arbitrary signal value within a range capable of being taken by a pixel value, ω is an arbitrary value, and t satisfies $t \geqq 1$).

14. A computer-readable storage medium which stores a process program composed of:

a detection process for detecting m ($m \geqq 1$) pixels from peripheral pixels of a noticeable pixel in input image information (a pixel value at an observation point among m points is defined as P(n));

an interpolation process for interpolating the noticeable pixel to plural pixels based on the input image information; and

a calculation process for calculating an output value h(k) based on an interpolation value C(k) interpolated at each interpolation point k, according to an following equation,

$$h(k) = \sum_{n=1}^{m} \alpha(n)P(n) + \beta C(k) + \sum_{s=1}^{t} \gamma(s)Q(s) + \omega$$

($\alpha(n)$, $\beta(\beta \neq 0)$ and $\gamma(s)$ are arbitrary coefficients, Q(s) is an arbitrary signal value within a range capable of being taken by a pixel value, ω is an arbitrary value, and t satisfies $m \geqq 1$).

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,400,413 B1
DATED : June 4, 2002
INVENTOR(S) : Miyake

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page,
Item [56], **References Cited**, FOREIGN PATENT DOCUMENTS,

"7093531	4/1995	-- 7-093531	4/1995
7105359	4/1995	7-105359	4/1995
7107268	4/1995	7-107268	4/1995
9252400	9/1997" should read	9-252400	9/1997 --.

Column 1,
Line 20, "the" should read -- a --; and
Line 56, "number" should read -- numbers --.

Column 2,
Line 1, "can not" should read -- cannot --; and
Line 52, "indow" should read -- window --.

Column 3,
Line 38, "can not" should read -- cannot --.

Column 7,
Line 1, "sharped" should read -- sharpened --.

Column 10,
Line 63, "can not" should read -- cannot --.

Column 12,
Line 17, "expect" should read -- except --.

Column 13,
Line 1, "claim 4," should read -- claim 4, wherein --.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,400,413 B1
DATED : June 4, 2002
INVENTOR(S) : Miyake

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 14,
Lines 12 and 36, "an" should read -- a --.

Signed and Sealed this

Twenty-second Day of April, 2003

JAMES E. ROGAN
Director of the United States Patent and Trademark Office

US006496276B1

(12) **United States Patent**
Dei et al.

(10) **Patent No.: US 6,496,276 B1**
(45) **Date of Patent: Dec. 17, 2002**

(54) **PRINTER HAVING AN INFRARED DATA RECEIVER**

(75) Inventors: **Koji Dei**, Kanagawa (JP); **Tadashi Yokouchi**, Kanagawa (JP)

(73) Assignee: **Sony Corporation** (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **08/936,764**

(22) Filed: **Sep. 24, 1997**

(30) **Foreign Application Priority Data**

Sep. 27, 1996 (JP) 8-256647

(51) **Int. Cl.**^{7} **G06F 15/00**
(52) **U.S. Cl.** **358/1.15**; 358/1.1
(58) **Field of Search** 395/114; 340/870.28, 340/870.29; 342/53; 455/151.2; 358/1.15, 1.13, 1.6, 1.1, 1.14; 709/200, 201, 242

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* cited by examiner

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(74) *Attorney, Agent, or Firm*—Rader, Fishman & Grauer PLLC; Ronald P. Kananen

(57) **ABSTRACT**

There is provided a printer, in which print data from an external electronic appliance is transmitted to a computer and processed therein, and the processed data is supplied to a printing unit, and then a picture based on that processed print data can be printed by means of the printing unit. This printer includes a parallel I/O terminal (or serial I/O terminal) to which a computer is connected, a built-in infrared ray transmitter/receiver to which the external electronic appliance having an infrared ray transmitter/receiver is connected through the infrared ray transmitter/receiver, a first transmitting path for connecting the parallel I/O terminal (or serial I/O terminal) and the built-in infrared ray transmitter/receiver, and a second transmitting path for connecting the parallel I/O terminal (or serial I/O terminal) and the printing unit.

14 Claims, 2 Drawing Sheets

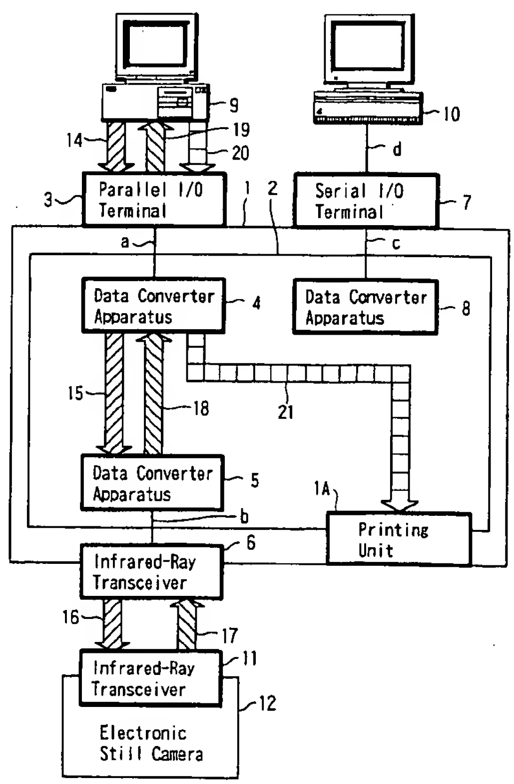


FIG. 1 PRIOR ART

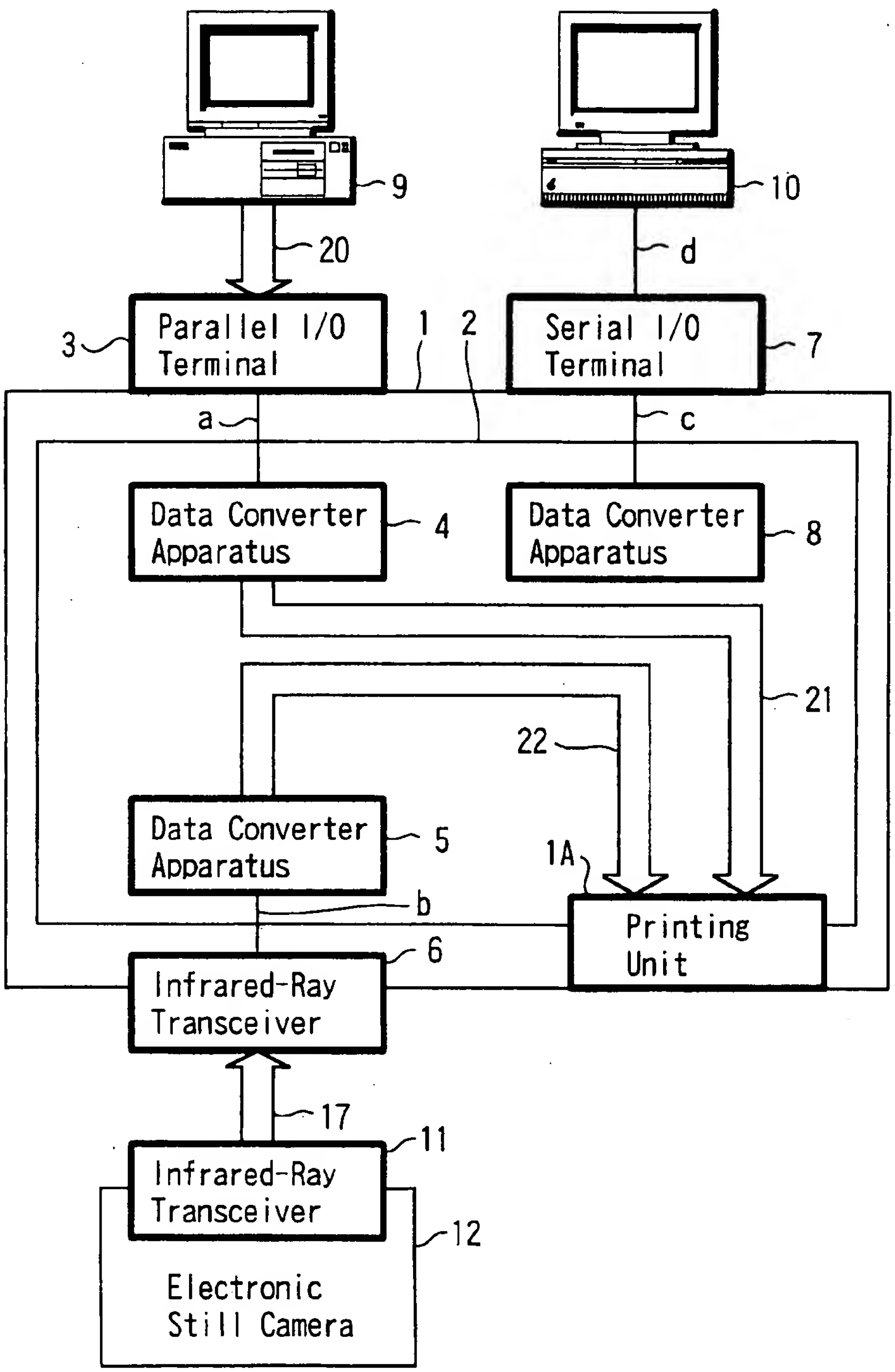
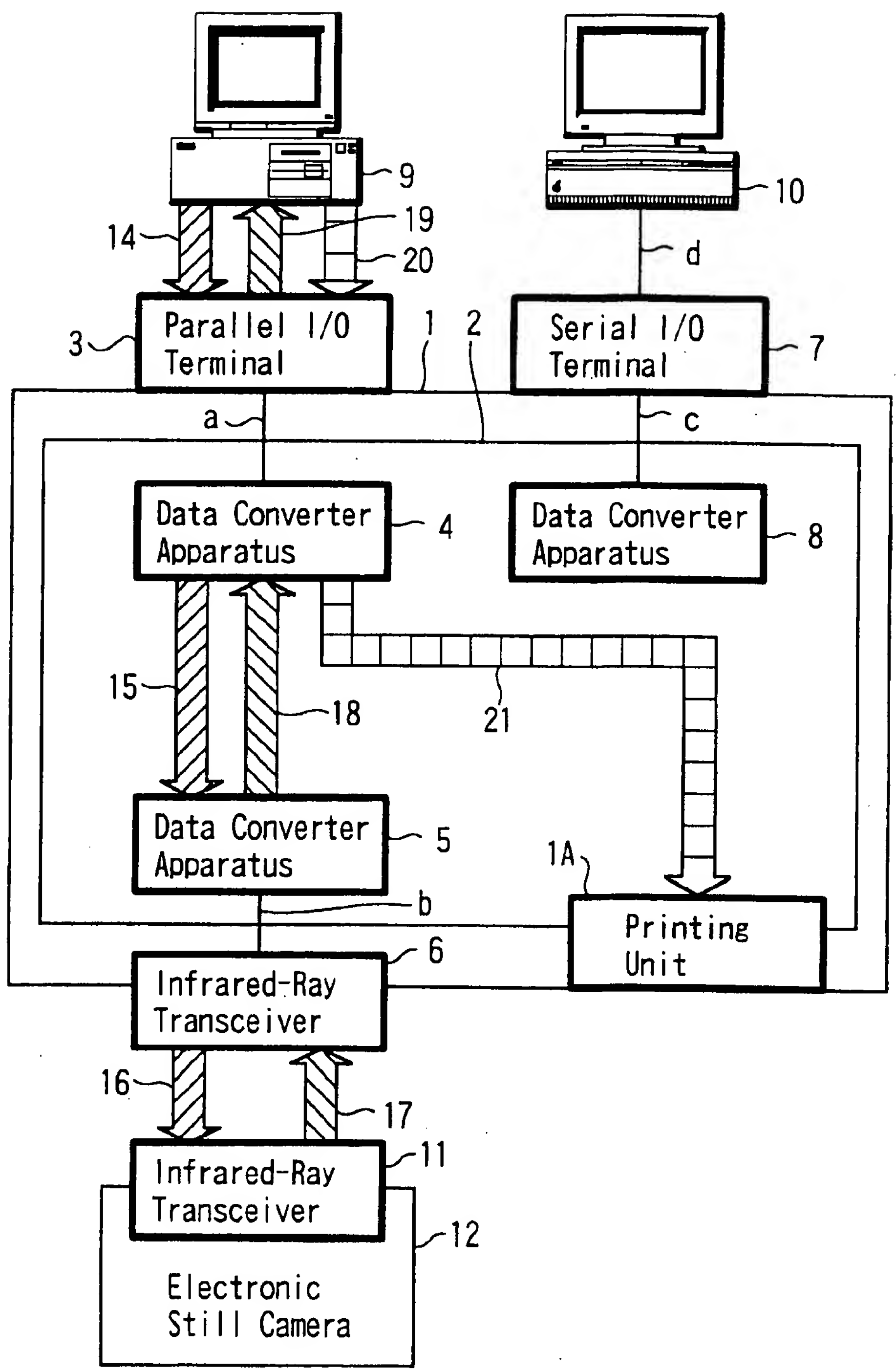


FIG. 2


9
10
14
19
20
d
Parallel I/O Terminal
Serial I/O Terminal
3
1
2
7
a
c
Data Converter Apparatus
4
Data Converter Apparatus
8
15
18
21
Data Converter Apparatus
5
1A
b
Printing Unit
Infrared-Ray Transceiver
6
16
17
Infrared-Ray Transceiver
11
12
Electronic Still Camera

PRINTER HAVING AN INFRARED DATA RECEIVER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a printer.

2. Background of the Invention

Hereinafter, a printer (e.g., sublimation type thermal transfer printer) will be described with reference to FIG. 1. Reference numeral 1 denotes a printer and reference numeral 1A denotes a printing unit thereof. The printer 1 includes a parallel I/O terminal 3, a serial I/O terminal 7 and an infrared ray transmitter/receiver (built-in infrared ray transmitter/receiver) 6. The printer 1 includes a data change-over apparatus 2.

The data change-over apparatus 2 contains data transforming devices 4, 5, 8 for performing serial/parallel mutual transformation. The data transforming device 4 is connected to the parallel I/O terminal 3 through a serial transmitting path a and also to the printing unit 1A through a parallel transmitting path 21. The data transforming device 5 is connected to the infrared ray transmitter/receiver 6 through a serial transmitting path b and also to the printing unit 1A through a parallel transmitting path 22.

The data transforming device 8 is connected to the serial I/O terminal 7 through a serial transmitting path c. Further, the data transforming device 8 can be connected to the printing unit 1A through a parallel transmitting path (not shown) when the data transforming device 4 is not connected to the printing unit 1A through the parallel transmitting path 21.

Reference numeral 9 denotes a personal computer, which is connected to the parallel I/O terminal 3 through a parallel transmitting path 20. Reference numeral 10 denotes a personal computer which is different from the personal computer 9 in terms of machine type, which is connected to the serial I/O terminal 7 through a serial transmitting path d.

Reference numeral 12 denotes an electronic still camera (digital camera) which is an example of an external electronic device and has an infrared ray transmitter/receiver 11. Then, an infrared ray transmitting path (space or optical fiber) 17 is formed between the infrared ray transmitter/receiver 11 and the infrared ray transmitter/receiver 6 of the printer 1.

Next, an operation of the printer 1 will be described. Print data from the personal computer 9 is transmitted to the printing unit 1A through the parallel transmitting path 20, the parallel I/O terminal 3, the serial transmitting path a, the data transforming device 4 and the parallel transmitting path 21. Then, the printing unit 1A can print a picture (picture in a narrow sense, or character or both of them) on a print paper (not shown) according to the print data.

The print data from the electronic still camera 12 is transmitted to the printing unit 1A through the infrared ray transmitter/receiver 11, the infrared ray transmitting path 17, the infrared ray transmitter/receiver 6, the serial transmitting path b, the data transforming device 5 and the parallel transmitting path 22. Then, the printing unit 1A can print a picture (picture in a narrow sense) according to the print data on a print paper (not shown).

Meantime, it is possible to transmit the print data from the personal computer 10 by using a parallel transmitting path between the data transforming device 8 and the printing unit 1A, instead of connecting the data transforming device 4 and the printing unit 1A by means of the parallel transmitting path 21, and supply that print data to the printing unit 1A, and print an image (picture in a narrow sense, or character or both of them) on a print paper (not shown) according to the print data.

In the aforementioned printer, the print data from an external electronic appliance such as an electronic still camera or the like is transmitted to the printing unit and the picture based on the print data can be printed on a print paper. However, according to this printer, it is impossible that the print data from the external electronic appliance is transmitted to the computer, processed therein, and then supplied to the printing unit, and the printing unit prints out a picture based on that processed print data on a print paper.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide a printer wherein a print data from an external electronic appliance is transmitted to a computer and processed therein and the processed data is supplied to a printing unit and a picture based on the processed print data can be printed by means of the printing unit.

According to the present invention, there is provided a printer which comprises an I/O terminal to which a computer is connected; a built-in infrared ray data receiver, a printing unit, a first transmitting path for supplying a signal output from the built-in infrared ray data receiver to the I/O terminal, and a second transmitting path for supplying the signal supplied from the I/O terminal to the printing unit.

According to the present invention with the above arrangement, the print data from the printer external electronic appliance is transmitted to the computer through the infrared ray transmitter/receiver, the built-in infrared ray transmitter/receiver, the first transmitting path and the parallel I/O terminal (or serial I/O terminal). The print data is processed therein and the processed data is supplied to the printing unit through the parallel I/O terminal (serial I/O terminal) and the second transmitting path. A picture according to the processed print data can be printed by means of the printing unit. In this case, the computer is capable of transmitting a command signal for making the print data from the external electronic appliance transmitted to the computer, to the external electronic appliance through the parallel I/O terminal (or serial I/O terminal), the first transmitting path, the built-in infrared ray transmitter/receiver and the infrared ray transmitter/receiver.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing a printer; and

FIG. 2 is a block diagram showing a printer according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Hereinafter, an embodiment of the present invention will be described with reference to FIG. 2. In FIG. 2, the same reference numerals as those of FIG. 1 denote the same parts. Reference numeral 1 denotes a printer (e.g., sublimation type thermal transfer printer, however the printer is not limited to this type). Reference numeral 1A denotes a printing unit. The printer 1 includes a parallel I/O terminal 3, a serial I/O terminal 7 and an infrared ray transmitter/receiver (build-in infrared ray transmitter/receiver) 6. The printer 1 includes a data change-over apparatus 2.

The data change-over apparatus 2 is provided with data transforming devices 4, 5, 8 for performing serial/parallel

mutual transformation. The data transforming device **4** is connected to the parallel I/O terminal **3** through a serial transmitting path a and also to the printing unit **1A** through a parallel transmitting path **21**. Further, the data transforming device **4** is connected to the data transforming device **5** through parallel transmitting paths **15, 18**. Although the parallel transmitting paths **15, 18** are a common transmitting path, apparently two transmitting paths are indicated to distinguish a transmission direction of the signal. The data transforming device **5** is connected to the infrared ray transmitter/receiver **6** through a serial transmitting path b.

The data transforming device **8** is connected to the serial I/O terminal **7** through a serial transmitting path c. When the parallel transmitting paths **21, 15, 18** are not connected between the data transforming device **4** and the printing unit **1A**, and between the data transforming devices **4** and **5**, it is possible to connect the parallel transmitting paths (not shown) between the data transforming device **8** and the printing unit **1A**, and between the data transforming devices **8** and **5**.

Reference numeral **9** denotes a personal computer, which is connected to the parallel I/O terminal **3** through the parallel transmitting paths **14, 19, 20**. Although the parallel transmitting paths **14, 19, 20** are a common transmitting path, apparently three transmitting paths are indicated to distinguish the signal transmitting directions and transmission signals. The data transforming device **5** is connected to the infrared ray transmitter/receiver **6** through the serial transmitting path b.

Reference numeral **10** denotes a personal computer which is different in type from the personal computer **9**. The personal computer **10** is connected to the serial I/O terminal **7** through a serial transmitting path A.

Reference numeral **12** denotes an electronic still camera (digital camera) which is an example of an external electronic device appliance and has an infrared ray transmitter/receiver **11**. Infrared ray transmitting paths **16, 17** are formed between the infrared ray transmitter/receiver **11** and the infrared ray transmitter/receiver **6** of the printer **1**. Although the infrared ray transmitting paths **16, 17** are a common infrared ray transmitting path (air or optical fiber), apparently two transmitting paths are indicated to distinguish the signal transmission directions.

Next, an operation of the printer **1** according to this embodiment will be described. The personal computer **9** generates a command signal for making the electronic still camera **12** transmit print data from the electronic still camera **12** to the personal computer **9**. This command signal is transmitted to the electronic still camera **12** through the parallel transmitting path **14**, the parallel I/O terminal **3**, the serial transmitting path a, the data transforming device **4**, the parallel transmitting path **15**, the data transforming device **5**, the serial transmitting path b, the infrared ray transmitter/receiver **6**, the infrared ray transmitting path **16** and the infrared ray transmitter/receiver **11**. Meanwhile, the serial transmitting path a, the data transforming device **4**, the parallel transmitting path **15**, the data transforming device **5** and the serial transmitting path b are assumed to be a first transmitting path.

Then, the print data from the electronic still camera **12** is transmitted to the personal computer **9** through the infrared ray transmitter/receiver **11**, the infrared ray transmitting path **17**, the infrared ray transmitter/receiver **6**, the serial transmitting path b, the data transforming device **5**, the parallel transmitting path **18**, the data transforming device **4**, the serial transmitting path a, the parallel I/O terminal **3** and the parallel transmitting path **19**. The serial transmitting path b, the data transforming device **5**, the parallel transmitting path **18**, the data transforming device **4** and the serial transmitting path a are also assumed to be the first transmitting path.

Then, the personal computer **9** processes the print data from the electronic still camera **12**. The processed print data is supplied to the printing unit **1A** through the parallel transmitting path **20**, the parallel I/O terminal **3**, the serial transmitting path a, the data transforming device **4** and the parallel transmitting path **21**. According to the processed print data, a print picture (picture in a narrow sense) can be printed on a paper (not shown) by the printing unit **1A**. Meanwhile, the serial transmitting path a, the data transforming device **4** and the parallel transmitting path **21** are assumed to be a second transmitting path.

The print data from the electronic still camera **12** can be transmitted to the printing unit **1A** without being processed by the personal computer **9**. In this case, the print data from the electronic still camera **12** is supplied to the printing unit **1A** through the infrared ray transmitter/receiver **11**, the infrared ray transmitting path **17**, the infrared ray transmitter/receiver **6**, the serial transmitting path b, the data transforming device **5**, the parallel transmitting path **18**, the data transforming device **4** and the parallel transmitting path **21**. A picture (picture in a narrow sense) based on that print data can be printed on a print paper (not shown) by means of the printing unit **1A**. Meanwhile, the serial transmitting path b, the data transforming device **5**, the parallel transmitting path **18**, the data transforming device **4** and the parallel transmitting path **21** are assumed to be a third transmitting path.

In a case when, instead of connecting the data transforming devices **4** and **5** through the parallel transmitting paths **15, 18** and connecting the data transforming device **4** and the printing unit **1A** through the parallel transmitting path **21**, the data transforming devices **8** and **5** are connected through parallel transmitting paths corresponding to the parallel transmitting paths **15, 18** and the data transforming device **8** and the printing unit **1A** are connected through a parallel transmitting path corresponding to the parallel transmitting path **21**, the personal computer **10** transmits a command signal for transmitting print data to the personal computer **10** to the electronic still camera **12**. The print data from the electronic still camera **12** is supplied to the personal computer **10**. Then, the print data is processed by the personal computer **10** and the processed print data is transmitted to the printing unit **1A**. According to that processed print data, the picture can be printed on a print paper (not shown) by means of the printing unit **1A**.

Instead of the electronic still camera **12**, a picture signal source such as a VTR, a television receiver and so on, or a character signal source such as a facsimile, a telex, a personal computer transmission terminal, an internet terminal and so on can be provided as an external electronic appliance.

Having described a preferred embodiment of the invention with reference to the accompanying drawings, it is to be understood that the invention is not limited to the precise embodiment and that various changes and modifications could be effected therein by one skilled in the art without departing from the spirit or scope of the invention as defined in the appended claims.

What is claimed is:

1. A printer for printing an image and connectable at an input/output terminal to a computer that can receive transformed print data, process the transformed print data and output processed print data, the printer comprising:

a cordless link that receives print data from an external appliance and transmits the print data along a first transmitting path;

a data transforming device connectable to the first transmitting path that receives the print data and outputs transformed print data along a second transmitting path, said second transmitting path connectable to the input/output terminal; and

a printing unit that receives the processed data from the data transforming device by way of a third transmitting path and prints the image;

whereby after the computer receives and processes the transformed print data, the computer outputs the processed data to the input/output terminal and the second transmitting path, said data transforming device receives the processed data from the second transmitting path and outputs the processed data along a third transmitting path, and

said printer acting as a conduit for said print data from the external appliance to said computer.

2. The printer of claim 1 wherein said cordless link is a bi-directional infrared communications link.

3. The printer of claim 2 wherein the input/output terminal is connectable to a parallel printer port.

4. The printer of claim 2, wherein the input/output terminal is connectable to a serial printer port.

5. The printer of claim 2, wherein at least one of the first, second and third transmitting paths is bi-directional.

6. A printer for printing an image comprising:

a cordless link that receives print data from an external appliance and transmits the print data along a first transmitting path;

a first data transforming device connectable to the first transmitting path that receives the print data and outputs first transformed print data along a second transmitting path;

a second data transforming device connectable to the second transmitting path that receives the first transformed print data and outputs second transformed print data along a third transmitting path;

an input/output terminal connectable to the third transmitting path and connectable to a computer, whereby the second transformed print data is transmitted to the computer for processing into processed print data, the processed print data from the computer is output to the third transmitting path and to the second data transforming device, said second data transforming device receives the processed print data and outputs transformed processed print data along a fourth transmitting path; and

a printing unit connectable to the fourth transmitting path that receives the transformed processed data and prints an image of the transformed processed print data;

said printer acting as a conduit for said print data from the external appliance to said computer.

7. The printer of claim 6, wherein the first transmitting path is a serial transmitting path, the second transmitting path is a parallel transmitting path, the third transmitting path is a serial transmitting path, and the fourth transmitting path is a parallel transmitting path.

8. The printer of claim 6, wherein the input/output terminal is a parallel terminal.

9. The printer of claim 6, wherein the input/output terminal is a serial terminal.

10. The printer of claim 6, wherein said cordless link is a bi-directional infrared communications link.

11. The printer of claim 6, wherein at least one of the first, second, third and fourth transmitting paths is bi-directional.

12. A printer system for printing an image comprising:

a cordless link that receives print data from an external appliance and transmits the print data along a first transmitting path;

a first data transforming device connectable to the first transmitting path that receives the print data and outputs first transformed print data along a second transmitting path;

a second data transforming device connectable to the second transmitting path that receives the first transformed print data and outputs second transformed print data along a third transmitting path;

an input/output terminal connectable to the third transmitting path that receives the second transformed print data;

a computer connectable to the third transmitting path that receives the second transformed print data, processes the transformed print data into processed print data and outputs the processed print data to the third transmitting path to the second data transforming device, said second data transforming device receives the processed print data and outputs transformed processed print data along a fourth transmitting path; and

a printing unit connectable to the fourth transmitting path, that receives the transformed processed data and prints an image of the transformed processed print data;

said printer acting as a conduit for said print data from the external appliance to said computer.

13. The printer system of claim 12, wherein the electronic appliance is one of an electronic still camera, a television, a video tape recorder, a facsimile machine, a telex machine, and an internet appliance.

14. A method of printing comprising the steps of:

generating a command signal to transmit print data and sending said command signal to an electronic appliance along a first bi-directional transmitting path, said bi-directional path located in a printer;

transmitting said print data from the electronic appliance along the first bi-directional transmitting path to a computer;

processing the print data at the computer and outputting processed print data;

transmitting said processed print data from the computer along a second transmitting path to a printing unit; and

receiving the processed print data at the printing unit and printing an image based on the processed print data.

* * * * *

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United States Patent [19]

Hsieh et al.

[11] **Patent Number: 5,969,750**

[45] **Date of Patent: *Oct. 19, 1999**

[54] **MOVING PICTURE CAMERA WITH UNIVERSAL SERIAL BUS INTERFACE**

[75] Inventors: **Peter H. Hsieh**, Sunnyvale, Calif.; **Shyh-Rong Wang**, Hsinchu, Taiwan

[73] Assignee: **Winbcnd Electronics Corporation**, Taiwan

[*] Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

[21] Appl. No.: **08/708,388**

[22] Filed: **Sep. 4, 1996**

[51] **Int. Cl.**[6] **H04M 11/00**

[52] **U.S. Cl.** **348/15**; 348/17; 348/387; 348/390

[58] **Field of Search** 348/14–20, 384–387, 348/388, 390

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Primary Examiner—Vivian Chang
Assistant Examiner—Xu Mei
Attorney, Agent, or Firm—Proskauer Rose LLP

[57] **ABSTRACT**

A camera is provided that can be connected to a processing system via an external connector outside of the housing of the processing system. The camera includes a camera housing. An imaging device is provided inside the camera housing that converts moving pictures to a video signal. A bit rate reduction circuit is also provided inside the camera housing and connected to the imaging device. The bit-rate reduction circuit reduces a bit rate of the moving picture signal so as to produce a bit-rate reduced video signal having a lower bandwidth than the video signal prior to bit rate reduction.

12 Claims, 4 Drawing Sheets

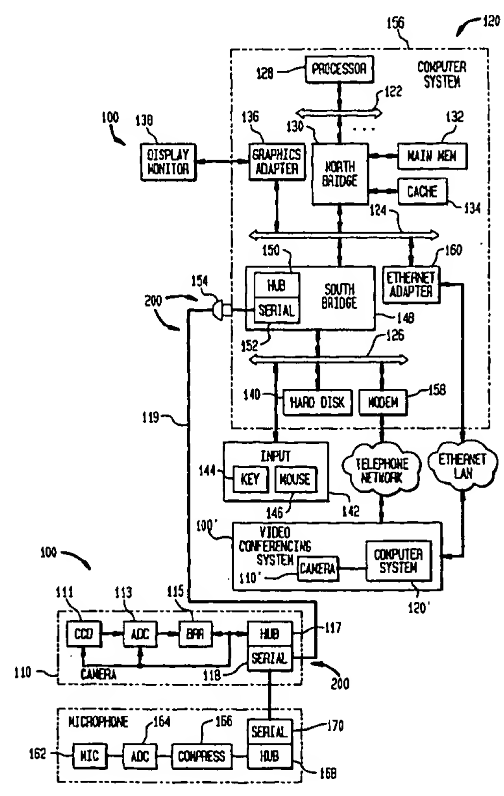


FIG. 1
(PRIOR ART)

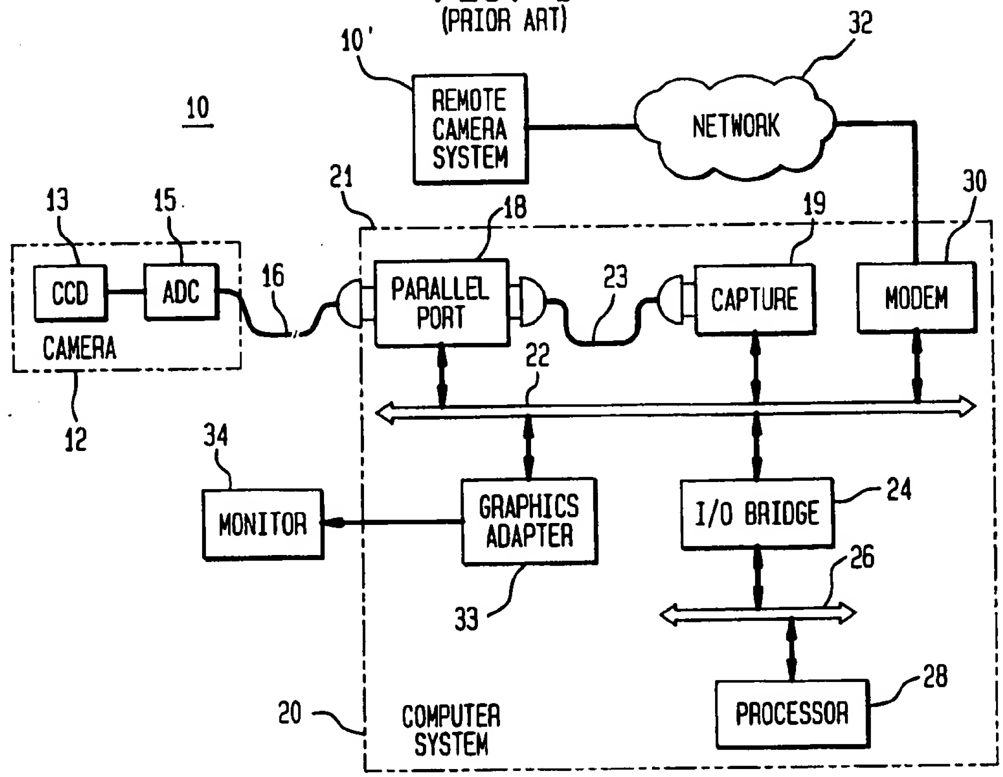


FIG. 2
(PRIOR ART)

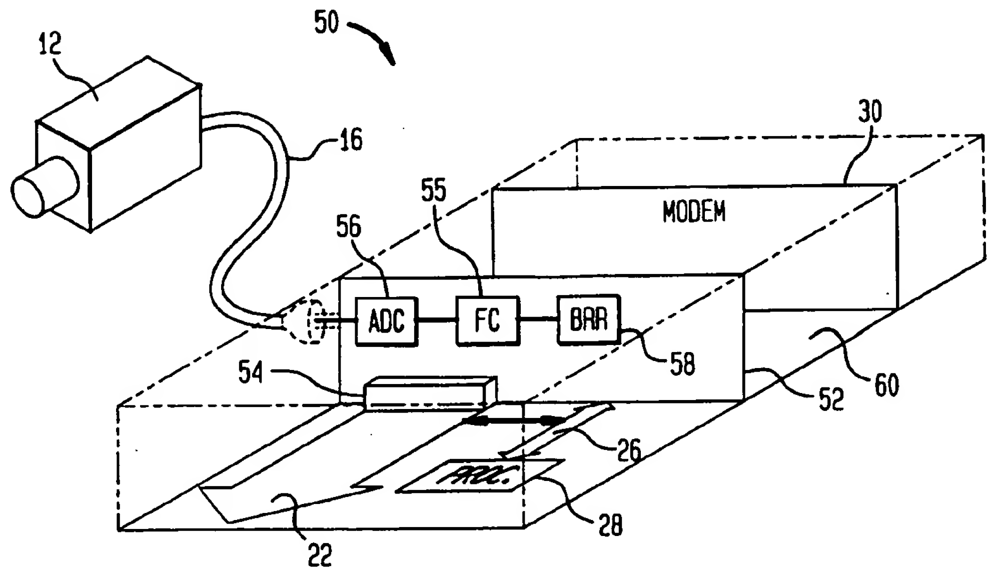


FIG. 3
(PRIOR ART)

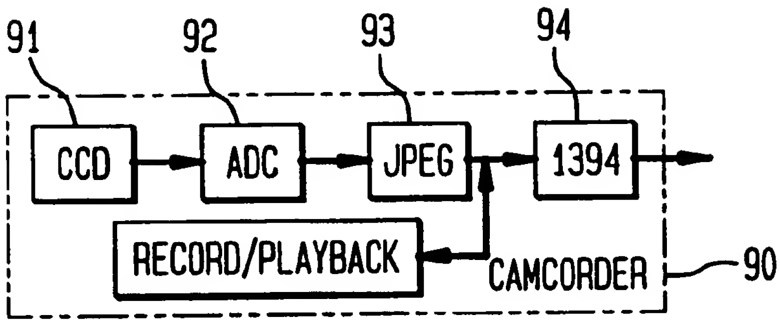


FIG. 4
(PRIOR ART)

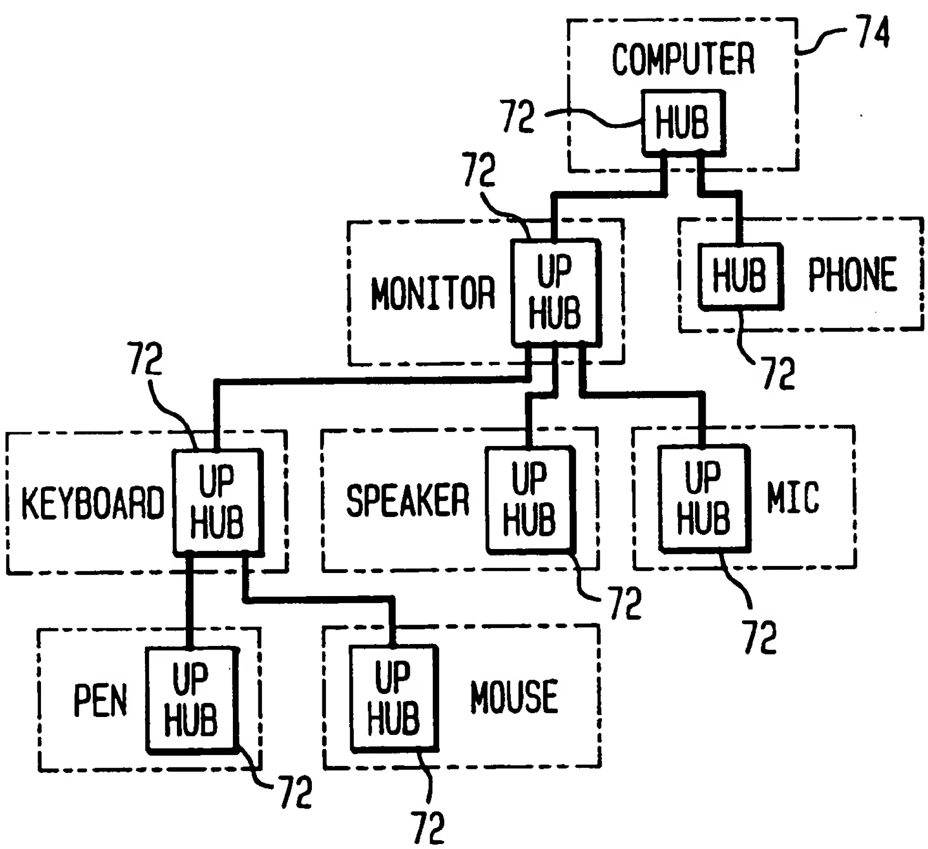


FIG. 5

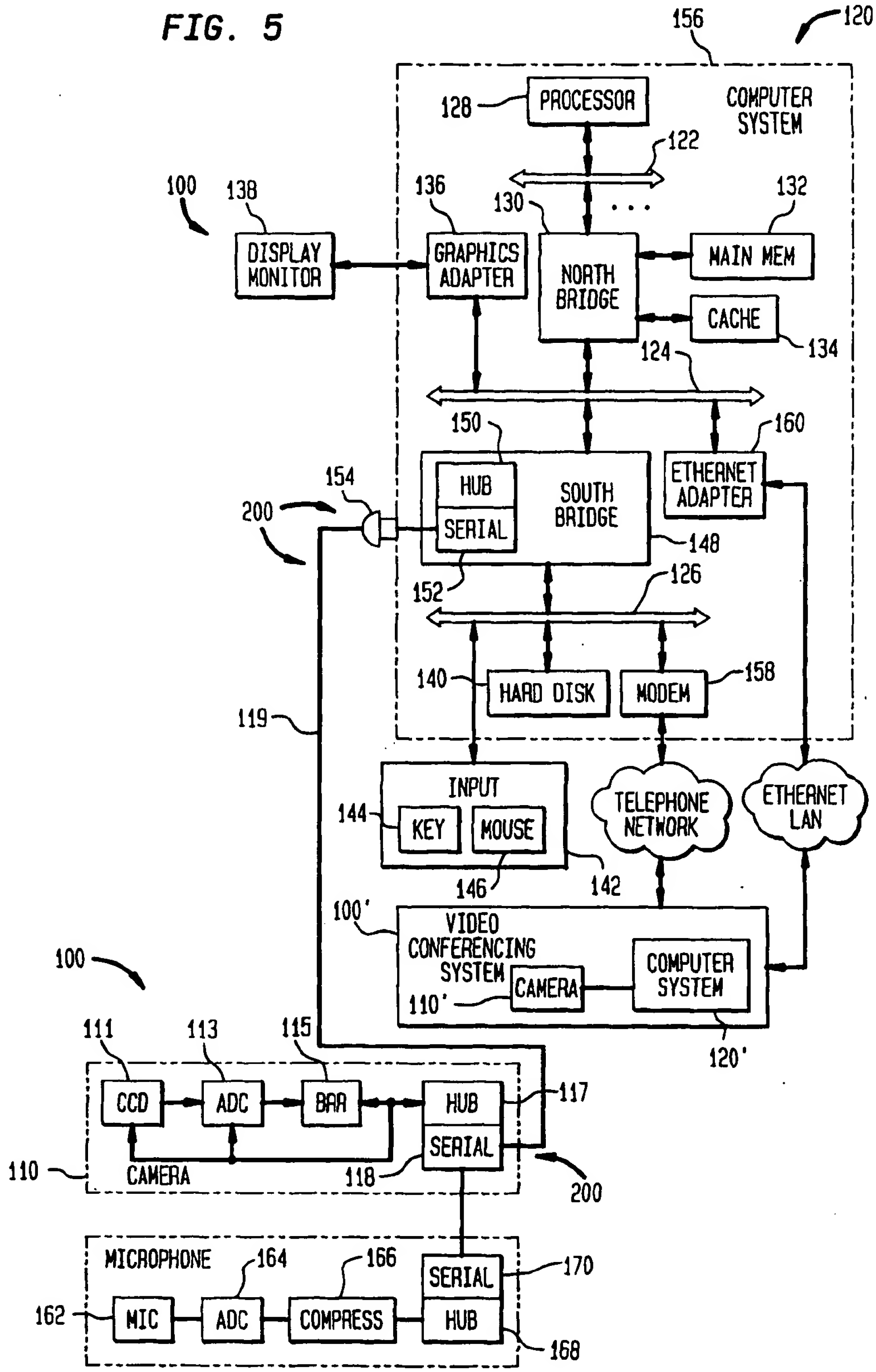

156
120
PROCESSOR
128
COMPUTER SYSTEM
122
100
138
136
130
132
DISPLAY MONITOR
GRAPHICS ADAPTER
NORTH BRIDGE
MAIN MEM
CACHE
134
124
150
160
154
HUB
SOUTH BRIDGE
ETHERNET ADAPTER
200
SERIAL
148
152
126
140
HARD DISK
MODEM
158
119
INPUT
144
KEY
MOUSE
TELEPHONE NETWORK
ETHERNET LAN
146
142
100'
VIDEO CONFERENCING SYSTEM
CAMERA
COMPUTER SYSTEM
110'
120'
100
111
113
115
CCD
ADC
BRR
HUB
117
SERIAL
110
CAMERA
118
200
MICROPHONE
164
166
SERIAL
170
162
MIC
ADC
COMPRESS
HUB
168

FIG. 6

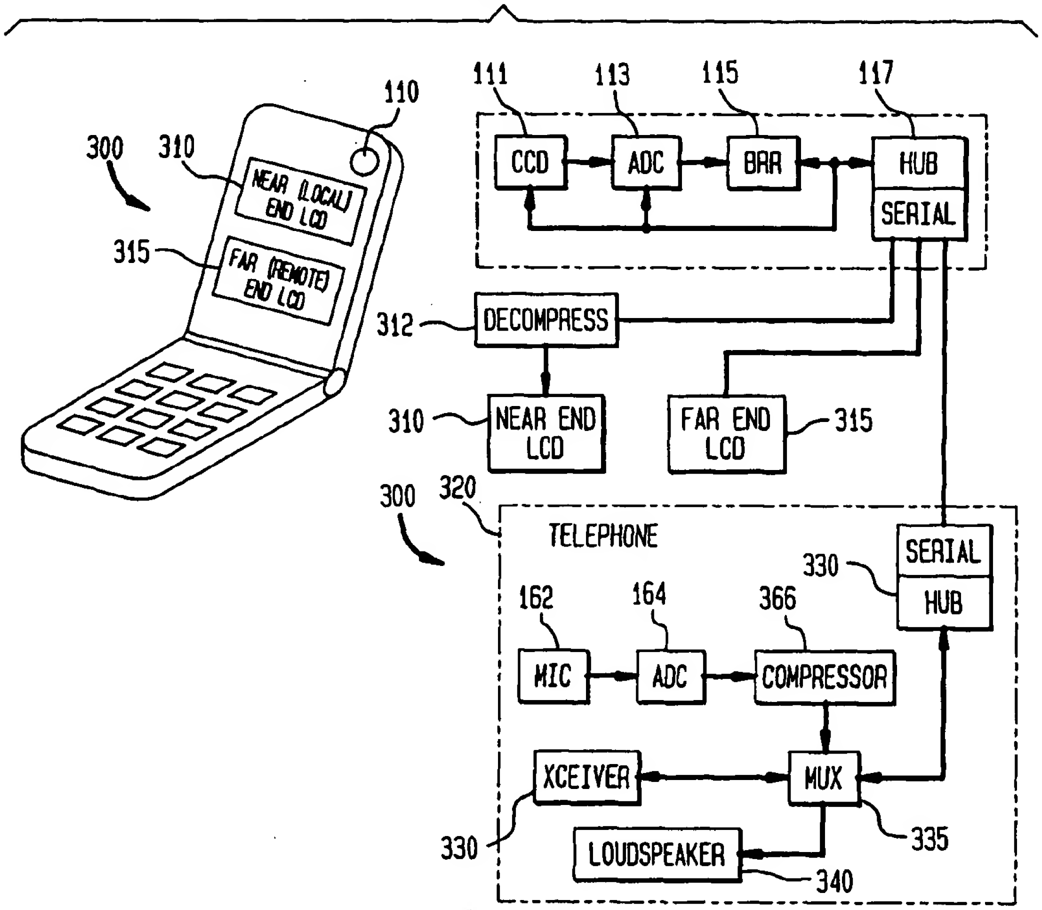
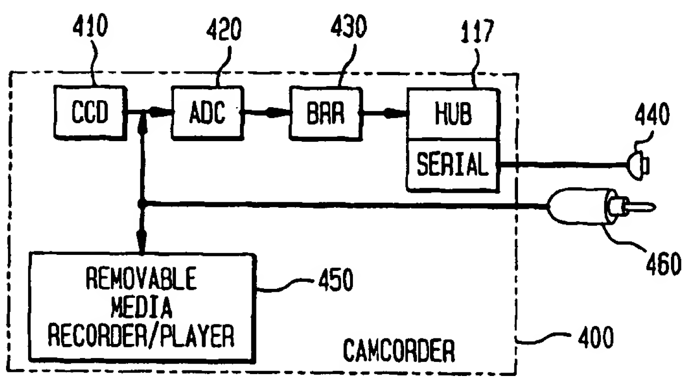

300
310
110
NEAR (LOCAL) END LCD
315
FAR (REMOTE) END LCD
111
113
115
117
CCD
ADC
BRR
HUB
SERIAL
312
DECOMPRESS
310
NEAR END LCD
FAR END LCD
315
300
320
TELEPHONE
SERIAL
330
HUB
162
164
366
MIC
ADC
COMPRESSOR
XCEIVER
MUX
330
335
LOUDSPEAKER
340

FIG. 7


410
420
430
117
CCD
ADC
BRR
HUB
SERIAL
440
460
REMOVABLE MEDIA RECORDER/PLAYER
450
CAMCORDER
400

MOVING PICTURE CAMERA WITH UNIVERSAL SERIAL BUS INTERFACE

FIELD OF THE INVENTION

The present invention relates to video. In particular, the present invention pertains to "plug and play" cameras that can be connected to, for example, a personal computer via a standard bus.

BACKGROUND OF THE INVENTION

FIG. 1 depicts a conventional video conferencing system **10**. A camera **12** of the video conferencing system **10** has a charge-coupled device or CCD **13** on which an image is incident. Cameras of the type illustrated in FIG. 1 called ColorCam are available from Connectix™ a company located in Mountain View, Calif. The CCD **13** outputs a still or moving picture video signal representing the image or images incident thereon to an analog to digital converter (ADC) **15**. The ADC **15** illustratively outputs an RGB format digital video signal. The digital video signal is conveyed by a cable **16** to a parallel printer port **18** of a computer system **20**. The picture data received from the parallel printer port **18** is provided to a frame capture I/O expansion card **19** via a proprietary internal cable **23**. The I/O expansion card **19** has a buffer for receiving frames of the digital video signals for communication via I/O expansion bus **22** to an I/O bridge **24**. The I/O bridge **24** retransmits the video data thus received via a system bus **26** to a processor **28**. Once at the processor **28**, the bit rate of the video signal may be adjusted in a number of ways. For instance, the resolution or frame rate may be decreased. Alternatively, the video may be encoded according to one of a number of encoding standards including ITU's (International Telecommunications Union) H.261, H.262, or H.263, ISO/IEC's MPEG-1, MPEG-2, JPEG, or motion JPEG, etc. After reducing the bit rate of the video signal sufficiently, the bit rate reduced video signal may be outputted from the processor **28**, via system bus **26**, I/O bridge **24** and I/O expansion bus **22** to a modem **30**. The modem **30** transmits the bit reduced video signal to a remote video conferencing system **10'** via a network **32**, such as a public telephone network, local area network (LAN), metropolitan area network (MAN), wide area network (WAN), etc. The bit rate reduced video signal is received at a like modem **30** and communicated to a like processor **28** where it is restored (decompressed, spatially and/or temporally interpolated, etc). The restored video signal is then outputted to a graphics adapter **33** and displayed on a display monitor **34**. Alternatively, the restoration can be performed on the graphics adapter **33** using specialized hardware.

A conventional personal computer system **20** generally only has two standard ports, namely, a parallel port and a serial port. The parallel port is typically used for outputting data to a printer and can output data at a maximum 100 Kbyte/sec burst transfer rate using a handshake protocol. The serial port, on the other hand, is typically connected to an input device, such as a mouse, or a modem and can typically only sustain a 115.2 Kbit/sec transfer rate (e.g., using a 16550 UART). As noted above, the camera **12** can connect to a standardized connector at the printer port **18**. This enables the camera **12** to be used with different platforms (e.g., different computer systems). However, to do so, the printer must be disconnected from the parallel port **18** as the parallel port **18** can only support data transfers between the computer system **20** and one other peripheral device (pursuant to its handshake protocol). This is disadvantageous. Another disadvantage of the computer system **20** is that the computer system housing (represented by **21**) must be opened to install the frame capture I/O expansion card **19** and to manually connected the proprietary connector **23** between the parallel port **18** and the frame capture I/O expansion card **19**. Thus, a novice user may find it difficult to install and to configure the camera **12**. Moreover, for many systems **20**, the warranty on the computer is voided if the computer housing **21** is opened by the user.

The camera **12** is well suited for non-real-time still picture capture. In capturing a still image, there is no requirement to transfer the data of the still picture from the camera **12** to the computer system **20** (or to, for example, another video conferencing system **10'**) in real time. A raw RGB signal for a 600×800 pixel display screen contains (800×600 pixels)·24 bits/pixel=11,520,000 bits. At the maximum 100 Kbyte/sec burst transfer rate of the parallel port **18**, the transfer of one still image from the camera **12** to the computer system **20** takes over 14 seconds (without adding in the overhead of the printer port **18** handshake protocol or any other bus arbitration of transfer latency of the computer system **20**). Moreover, to transfer such information via modem **30** connected to an ordinary telephone network (which can have up to a 28.8 Kbit/sec transfer rate) would require 400 sec. This presents a problem for real time video communication, such as, video conferencing, in which moving pictures must be captured, transferred, and displayed in real time.

It is possible to program processor **128** to perform a limited amount of real time video capture for transfer via the network **32** using the video conferencing system **10**. The problem is that only a limited amount of data can be transferred from the camera **12** via the printer port **18** to the frame capture I/O expansion card **19** due to the limited bandwidth of the printer port **18**. As such, the resolution of the image must be drastically reduced to no larger than 128×96 pixels (for a black and white image) which results in approximately a 2"×2" picture on a normal display monitor **34**. The frame rate is reduced to approximately 7 frames per second (using a frame dropping technique). (Note that (128×96)·(8 bits/pixel)·(7 frames/second)=688,128 bits/sec which is slightly less than the 100 kbyte sec maximum bust transfer rate of the parallel port **18**.) Moreover, the image quality is severely deteriorated; ghost shadows are perceptibly present in the restored image, and the image breaks up whenever there is a large degree of motion in the picture.

FIG. 2 shows a modified video conferencing system **50**. In this system **50**, the camera **12** produces either an analog signal or a digital RGB signal carried by cable **16**. The signal is received at a video processing I/O expansion card **52** that is inserted into an available slot **54** on the I/O expansion bus **22**. The I/O expansion card **52** can have a frame capture circuit **55**, an ADC **56** and a bit rate reduction circuit **58** (e.g., a video compressor or frame rate/resolution reduction circuit). Examples of such circuits include the Vision Controller Processor (VCP™) available from 8×8™, a company located in Santa Clara, Calif., and APV-3™ available from Lucent™, a company located in Murray Hill, N.J. The video signal is received at the video bit rate reduction circuit **58** on the video card **52** and is bit rate reduced thereat. The bit rate reduced video signal is then transmitted on the I/O expansion bus **22** to the processor **28** and/or to the modem **30**.

The video conferencing system **50** can provide an adequate frame rate and resolution video signal at a bit rate which can be transmitted via the modem **30**. The problem with the system **50** is that the computer housing **60** must still

be opened to install the video processing I/O expansion card **52**. Second, the cable **16** connects to a non-standardized connector **62** on the video processing I/O expansion card **52**. This reduces the interchange-ability of video cameras **12** from platform to platform.

FIG. **3** shows an IEEE 1394 compliant camcorder **90** soon to be available from Sony™ a company located in Tokyo, Japan. The IEEE 1394 standard is a new standard for compression, storage and transfer of consumer and professional use digital video signals. The camcorder **90** includes a CCD **91**, an ADC **92**, a motion JPEG compressor **93** and an IEEE 1394 interface **94**. A video signal outputted from the CCD **91** is converted to digital form in ADC **92** and then compressed in JPEG compressor **93**. The compressed video signal is then formatted according to the IEEE 1394 standard and outputted to a bus using interface **94**. The IEEE 1394 bus is a 400 Mbit/sec bus for which no computer interface is yet available. Moreover, the IEEE 1394 bus is designed for transfer of video signals only--no specific provisions are provided for supporting non-video "bursty" data transfers.

Another problem specific to both the video conferencing system **10** and video conferencing system **50** pertains to properly setting up the system on each end of the communication. For instance, there is no guarantee that both the video conferencing system **10** and the video conferencing system **10'** will use the same camera, the same frame captured board or technique, or have the same coding/decoding capabilities. Even when both video conferencing systems on each end of the communication are identical, a skilled operator is necessary to properly install the hardware and software and also to configure the software and hardware each session. In particular, the operator must select the correct software drivers, select compatible bit rate reduction methodologies, i.e., the correct encoding and decoding technique, options and parameters, the correct resolution, the correct frame rate, etc. In the case where each end of the communication need not have an identical video conferencing system **10** or **10'** each operator must be provided with preliminary information on the capabilities of the system at the other end and must somehow agree to select the correct frame rate, resolution, encoding/decoding technique parameters and options. This makes it difficult for a novice user to establish an interactive video teleconference with an arbitrary user.

It is object of the present invention to overcome the disadvantages of the conventional cameras. In particular, it is object to provide a video conferencing system in which the camera can be connected to a standard computer port without opening the computer housing, yet have sufficient resolution and fidelity to enable interactive communication of moving pictures. It is also an object to provide other kinds of video peripherals which can output and receive video signals in a simple "plug and play" fashion. It is furthermore an object to provide a video conferencing system that can arbitrate with a like far end video conferencing system and automatically configure itself on a session by session basis.

SUMMARY OF THE INVENTION

These and other objects are achieved by the present invention. An illustrative environment of use of the present invention is a video conferencing system including a first housing. A bus is contained in the first housing. A processor contained in the first housing is connected to the bus. A first interface is also contained in the first housing and connected to the bus. The first interface has a serial port that is accessible externally to the computer housing and to which a connection can be made externally with a standard connector.

According to one embodiment, a camera is provided that can be interconnected to the first interface, e.g., via a communications medium. The camera includes a camera housing. An imaging device, such as a CCD, tube, or CMOS photosensor, is provided inside the camera housing that converts moving pictures to a video signal. A bit-rate reduction circuit is also provided inside the camera housing and connected to the imaging device. The bit-rate reduction circuit reduces a bit rate of the moving picture signal so as to produce a bit-rate reduced video signal having a lower bandwidth than the video signal prior to bit rate reduction.

Illustratively, a second interface is provided inside the camera housing and connected to the bit-rate reduction circuit. The second interface circuit communicates the bit-rate reduced video signal outside of the camera housing as a serial bitstream to the first interface via the communications medium. Illustratively, both the first and second interfaces are bidirectional. The first interface can download instructions to the bit rate reduction circuit via the second interface. Such instructions can include instructions for varying the bit-rate reduction by the bit-rate reduction circuit, e.g., resolutions and frame rates, compression technique or various compression parameters.

According to another illustrative embodiment, the camera contains at least one register or memory which contains information on the bit rate varying capabilities of the camera. Such information can be downloaded via the interfaces and communications medium to the processor in the first housing. The processor in the first housing may execute suitable software according to which the processor determines the picture resolution, frame rate, compression, etc. capabilities of its attached camera. The processor then may communicate with a like far end video conferencing system which also possesses information about the capabilities of its attached camera. Over the course of the communication, the two video conferencing systems negotiate acceptable bit rate reduction techniques (i.e., a compatible resolution, frame rate, compression technique, compression parameters, compression options, etc). In particular, the far end video conferencing system transfers to the processor information regarding moving picture restoration capabilities at the far end. As a result of these negotiations, the processor downloads appropriate instructions to the second interface for varying the bit rate reduction so as to produce a bit rate reduced video signal that can be restored by the far end video conferencing system.

By reducing the bit rate of the video signal prior to transfer to the first housing, it is possible to input the video signal via a serial port and connector already provided on the computer for lower bandwidth data transfers. Thus, it is not necessary to open the first housing to install an interface card for receiving the video signal. On the other hand, the bandwidth of the video signal can be reduced in a controllable fashion, e.g., by resolution reduction, compression, or a combination thereof, to maintain acceptable fidelity.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** shows a first conventional video conferencing system.

FIG. **2** shows a second conventional video conferencing system.

FIG. **3** shows a conventional camcorder.

FIG. **4** shows a conventional Universal Serial Bus architecture.

FIG. **5** shows a video conferencing system according to an embodiment of the present invention.

FIG. 6 shows a cellular telephone according to an embodiment of the present invention.

FIG. 7 shows a camcorder according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

According to the present invention, the bandwidth of the video signal produced by the camera is reduced so that the video signal can be inputted to an existing serial port of a computer system. The existing serial port has a connector that is external to the computer system and therefore the user need not open the computer system housing to install the camera. Thus, installation of the camera is simplified. Moreover, many manufacturers provide that the warranty on the computer is voided if the user opens the computer housing. As such, the invention also allows the user to circumvent a potential voiding of the computer system warranty.

In an illustrative environment of use, a camera is connected to a Universal Serial Bus (USB) interface. See Open HCI, Universal Serial Bus Specification v.1.0, Jan. 19, 1996. USB is a bus and interface standard recently adopted by both computer system manufacturers and peripheral equipment manufacturers. USB is a packet switch medium, such that it can support, e.g., instruction and video packets having address information. FIG. 4 shows a computer system with peripherals, such as a display monitor, keyboard, mouse, loudspeaker, microphone, telephone, etc., connected according to the USB architecture. Each peripheral illustratively has a hub circuit **72** with one upstream port and one or more downstream ports. The upstream direction is towards the computer system **74**. The downstream direction is away from the computer system **74**. Peripherals can be connected in any arbitrary tree topology with the computer system **74** at the root.

Communication on the USB is via a serial bitstream in either an isochronous or asynchronous fashion. Each hub therefore contains both transmit and receive circuitry. Communication can be achieved at a predefined "slow" rate of about 1.2 Mbits/sec or a full rate of up to 12 Mbits/sec.

The USB standard, in addition to specifying a protocol for communication on the serial bus, also specifies a standard connector. The manufacturers which have adopted the USB standard will deliver future computers and peripherals with such standard connectors located externally to the housing of the computer systems and peripherals. Thus, all monitors, keyboards, microphones, etc, will be easily connected using standard cabling. Furthermore, USB provides a protocol for the computer **74** to recognize each device connected thereto. This simplifies installation of hardware components. Devices possessing such installation simplifications, i.e., simple connection and auto-recognition and configuration, are frequently said to be "plug and play."

FIG. **5** illustrates a video conferencing system **100** according to an embodiment of the present invention. As shown, a camera **110** is connected to a computer system **120** externally to the housing **156** of the computer system **120**. The computer system **120** illustratively includes a cpu bus **122**; a system bus **124** (e.g., a PCI bus) and an I/O expansion bus **126** (e.g., as ISA bus). Connected to the cpu bus **122** is at least one processor **128** and a "north" bridge or memory controller **130**. The north bridge **130** connects a cache **132** and a main memory **134** to the processors **128** on the cpu bus **122**. The north bridge **130** also enables data transfers between devices on the system bus **124** and the memories **132** and **134** or the processors **128**. Also connected to the system bus **124** is a graphics adapter **136**. A display monitor **138** may be connected to the graphics adapter **136**. As shown, an Ethernet adapter **160** may be connected to the system bus **124**.

Connected to the I/O expansion bus **140** is a disk memory **140** and interface, such as an IDE interface, a modem **158**, and input devices **142** such as keyboard **144** and mouse **146**. (Alternatively, the keyboard **144** and mouse **146** may also be connected to the USB hub **150**.) Also connected between the system bus **124** and the I/O expansion bus **126** is a south bridge **148** or I/O bridge. The south bridge **148** enables data transfers between devices on the I/O expansion bus **126**, such as modem **158**, and devices on the USB **200** or devices on the system bus **124**. Illustratively, according to the invention, the south bridge **148** also includes a USB hub **150**. The USB hub **150** has one or more serial ports **152** that are connected to standard USB compliant connectors **154** to which a connection may be made totally externally to the housing **156** of the computer system. Illustratively, the USB hubs **150**, **117**, **168** and cables **119** form the USB bus **200**.

Note that the south bridge **148** contains buffers for decoupling transfers amongst the system bus **124**, I/O expansion bus **126** and hub **150**. No "capture" or extra buffering capability is necessary to enable full rate data transfers on the USB **200** to the hub **150**.

The camera **110** is shown as including an imaging device, such as a tube, CMOS photo sensor or CCD **111**, on which video images are incident. The imaging device **111** converts the image to a motion picture video signal representative thereof. The video signal is converted to digital form in ADC **113**. The digital signal outputted from ADC **113** is received at a bit rate reduction circuit **115**. The bit-rate reduction circuit **115** may be a programmable frame rate/resolution reduction circuit. Advantageously, however, the bit rate reduction circuit is a programmable compressor. The bit rate reduced video signal is outputted to a USB hub circuit **117**. The USB hub circuit **117** has a serial port **118** that can output the video signal as a serial bitstream via cable **119**. The cable **119**, which is plugged into the connector **154** (externally to the computer housing **156**), delivers the video signal to the serial port **152** of the hub circuit **150** in the south bridge **148**.

The reduction of the bit rate by the bit rate reduction circuit **115** ensures that the video signal has a sufficiently low enough bandwidth to be received by the USB serial port **152**. Table 1 summarizes the average bit rates produced according to several well known standards:

TABLE 1

Standard	Bit Rate
H.261	128 Kbits/sec
H.263	20 Kbits/sec
MPEG-1	1.55 Mbits/sec
MPEG-2	4–80 Mbits/sec.

For instance, as noted in Table 1, a fairly high quality interlaced video signal can be compressed to an average bit rate of 1.55 Mbits/sec using the MPEG-1 technique or 4–80 Mbits/sec using the MPEG-2 technique. However, H.261, H.262 and H.263 can compress a video signal to even 15–20 kbits/sec with adequate quality for interactive video communication. On the other hand, the bit rate reduction circuit **115** may be a less sophisticated circuit which merely reduces the resolution and/or frame rate of the video signal. In such a case, the reduction in bit rate may be less, e.g., a reduction to 4–8 Mbits/sec. If the bit rate is not sufficiently low enough

to transfer the video data via a network, the processor **128** illustratively may be programmed with suitable software for compressing the bit rate reduced video according to the MPEG-1, MPEG-2, H.261, H.262, H.263, JPEG, motion JPEG, etc. compression standards. In such a case, however, a compressor preferably is provided in computer system **120** that is connected to the system bus **124**.

As noted above, the USB **200** can be used to connect multiple peripherals in a tree topology. For instance, the peripherals such as the keyboard **144**, mouse **146**, modem **158**, microphone **162**, etc. can also be connected to the USB **200**. In such a case, the data transfers to and from these additional peripherals are interspersed with each other and with the transfer of the video signal from the camera **110**. Several constraints must be imposed to enable both "bursty" data transfers to and from these other peripherals and continuous video signal transfers. First, the camera **110** should not obtain so much of the bandwidth of the USB **200** so as to "starve," i.e., prevent the other peripherals from communicating. Second, real time video requires continuity. To ensure continuity, a decoder at the far or receive end of the video signal must always have video signal data available for decoding. Simply stated, to avoid perceptible discontinuities or gaps in the video signal, video signal data must be delivered in a timely fashion. On the other hand, the video signal takes a certain amount of time to decode and display on the far or receive end (e.g., frames must be displayed for a frame time). If too much video signal data is delivered at one time, a buffer overflow can occur at the receive end decoder. In order to accommodate the above constraints, the following guidelines are illustratively used:

(1) the USB **200** is operated at the full bit rate,

(2) the USB **200** is operated in isochronous communication mode, and

(3) an elaborate arbitration scheme is used to prevent peripheral communication starvation and to ensure continuity of the video signal.

Generally speaking, the second guideline can be ensured by the first guideline. The second guideline allows for orderly scheduling of peripheral and video signal data transfers in achieving the third guideline.

Note that the USB **200**, in particular, the serial ports **118** and **154** of the hubs **150**, **117**, **168** support bidirectional transfer of signals. To that end, the serial port of each hub **150**, **117**, **168** has both transmit and receive circuitry. In addition to transferring video signals from the hub **117** to the hub **150**, data may be transferred from the hub **150** to the hub **117** by interspersing the video signal and the data transfer signal. Such data transfers can be used to program/adjust the bit rate reduction circuit **115** (the ADC **113** and/or the imaging device **111**) to vary the bit rate reduction. Programmable compressors **115** are available which include basic spatial and temporal compression sub-circuitry and processors, such as RGB to YUV converters, discrete cosine transformers, inverse discrete cosine transformers, quantizers, dequantizers, variable length encoders, video buffer verifiers, motion estimators, motion compensators, block matchers, loop filters, inter/intra decision circuits, etc. Illustratively, such programmable processors can be programmed to compress the video in compliance with a number of compression standards such as, H.261, H.262, H.263, MPEG-1, MPEG-2, JPEG, motion JPEG, etc. Furthermore, within any given standard, different parameters may be adjusted such as quantization step sizes, inter/intra decision thresholds, group of picture formats, bit rate, etc and different compression options, such as arithmetic coding, may be selected. Illustratively, the bit rate reduction circuit **115** can be programmed by means of a transfer of data and/or instructions via the USB **200**. Even a simple resolution/frame rate reduction circuit **115** has programmable parameters such as resolution, number of frames per second, frame dropping rate, etc. For example, the bit rate reduction circuit **115**, ADC **113**, and/or imaging device **111** can be programmed to drop a certain fraction of frames or to change the frame interval, e.g., to change the frame sampling time from 1/30th of a second to say 1/6th of a second. The latter frame integration technique tends to produce a smoother lower frame rate video signal than the frame dropping technique. Illustratively, data may be transferred via the USB **200** to the bit rate reduction circuit **115** or imaging device **111** for varying the resolution, frame interval, frame dropping rate, etc.

Note that at least the bit-rate reduction circuit **115** contains registers and/or memory in which information indicating the bit rate variation capabilities, i.e., compression standards, adjustable compression parameters, selectable compression options, supported transfer bit rates, frame rates, resolutions, etc., may be stored. Such information may be prestored in a ROM or may be loaded into the bit rate reduction circuit **115** on power-up during an auto-configure procedure of driver software executed by the processor **128** for configuring the camera **110**. The capability information can be downloaded via USB **200** to the processor **128** and/or transferred to a remote video conferencing system **100'** in the course of negotiating video conferencing terminal capabilities (i.e., display resolution, communications rate and parameters, bit rate reduction capabilities, etc.) in setting up of a communication. For example, when a user at the near end, local video conferencing system **100** (camera **110** and computer system **120**) initiates a communication with a far end, remote video conferencing system **100'** (camera **110'** and computer system **120'**), the processor **128** at the near end, local video conferencing system **100** obtains the capability information stored in the registers or memory of the bit rate reduction circuit **115** of the camera **110**. To that end, the processor **128** transfers an instruction requesting such information via cpu bus **122**, north bridge **130**, system bus **124**, south bridge **148**, hub **150**, cable **119** and hub **117**, to bit rate reduction circuit **115**. In response, the bit rate reduction circuit **115** transfers such information to the processor **128** via hub **117**, cable **119**, hub **150**, south bridge **148**, system bus **124**, north bridge **130** and cpu bus **122**. The processor **128** may select a subset of bit rate reduction capabilities that can be accommodated by the modem **130** or Ethernet adapter **160** (whichever is used for the communication). The processor **128** also determines the picture restoration capabilities of (i.e., decoding techniques, parameters and options, and temporal and spatial interpolation capabilities supported by) the computer system **120**. Information regarding the bit rate reduction and picture restoration capabilities at the near end, local video conferencing system **100** may be transferred to the far end, remote video conferencing system **100'**. The far end, remote video conferencing system **100'** also obtains the bit rate reduction and picture restoration capabilities of the camera **110** and monitor **138** thereat. The near end, local video conferencing system **100** (camera **110** and computer system **120**) and the far end, remote video conferencing system **100'** (camera **100'** and computer system **120'**) then negotiate which bit rate reduction methodologies to use. In the course of the negotiation, the video conferencing system at each end of the communication can transfer its bit rate reduction and picture restoration capabilities to the other end in an effort to determine a bit rate reduction and a picture restoration methodology. When the negotiation is complete,

the processor **128** downloads instructions and information to the camera **110** for varying the bit rate reduction using a methodology for which the far end, remote video conferencing system **100'** can restore the pictures as per information received from the far end, remote video conferencing system **100'** regarding its picture restoration capabilities. Likewise, the processor **128** obtains the correct information for restoring received pictures that are bit-rate reduced by the far end, remote video conferencing system **100'** as per information received from the far end regarding its bit rate reduction capabilities.

Advantageously, a microphone **162** receives an audible sound and converts it to an audio signal in real time as the cameral **110** receives an image. An ADC **164** digitizes the audio signal and an audio compressor **166** compresses the audio signal. Illustratively, a USB hub circuit **168** receives the compressed audio signal and transmits it in bit serial form from serial port **170** to the hub **117**, interspersed with the video signal outputted from the camera **110** and any other data signal transmitted on the USB **200**.

The hub **150** receives the video (and illustratively the audio signal). The received signals may be transferred via south bridge **148**, system bus **124**, and north bridge **130** into one of the memories **132** or **134**. From there, the video and/or audio signal may be processed by the processor **128**, e.g., error protected using an error protection code, compressed, if necessary, etc. The video and/or audio signal may then be outputted (in multiplexed form) via north bridge **130**, system bus **124**, Ethernet adapter **160** and an ethernet network to the far end, remote video conferencing system **100'** of similar architecture as the video conferencing system **100**. Alternatively, or in addition, the video and/or audio signal can be outputted via north bridge **130**, system bus **124**, south bridge **148**, I/O expansion bus **126**, modem **158** and a public telephone network to the far end, remote video conferencing system **100'**. In another embodiment, the video and/or audio signal received at the hub **150** is outputted directly to the Ethernet adapter **160** or modem **158**, both of which can be connected to the USB **200**.

A video and/or audio signal may be received from the far end, remote video conferencing system **100'** at the near end, local video conferencing system **100** shown in FIG. **5**. The video and/or audio signal may be received at the ethernet adapter **160** or at the modem **158**. A video and/or audio signal received at the ethernet adapter **160** may be transferred via system bus **124** and north bridge **130** to main memory **132** or cache memory **134**. Alternatively, if the video and audio signal are received at the modem **158**, the video and audio signal are transferred via the I/O expansion bus **126**, south bridge **148**, system bus **124** and north bridge **130** to the memory **132** or **134**. From there, the processor **128** may separate the video and audio signals for further processing such as error correction, decryption, and restoration (i.e., decompressing, spatial/temporal interpolation, etc.). Alternatively, a special purpose processor (not shown) may be connected to the system bus **124** for performing at least the video signal restoration. In yet another embodiment, a special processor for performing video restoration may be included with the graphics adapter **136** to which the non-restored video signal is directly transferred (i.e., from the modem **158** or Ethernet adapter **160**). The restored video signal is transferred to the graphics adapter **136** (or is present thereat). The graphics adapter **136** outputs the restored video signal on the display monitor **138**. In addition, the restored audio is also received via the graphics adapter **136** and outputted to a loudspeaker contained in the display monitor **138**. Alternatively, an external loudspeaker can be connected to the USB **200**. The audio signal can be restored by a number of devices, such as the processor **128**. The restored audio signal is then outputted via the USB **200** to the loudspeaker.

The system **100** according to the present invention achieves the following advantages:

(1) Because the housing **156** need not be opened to install the camera **110**, the user may install the camera **110** without voiding a manufacturer warranty on the computer system **120**.

(2) Because the housing **156** need not be opened to install the camera **110**, a novice user can easily install the camera **110** by simply plugging cable **119** into a standard connector **154**. Using an auto-recognition process native to the USB standard, the camera **110** is automatically recognized and appropriate driver software for using the camera **110** can automatically be selected.

(3) The cost of the system **100** is reduced. This is because no video capture board is needed to receive the video signal as is required in either the system of FIGS. **1** and **2**.

(4) The camera **110** is connected to the computer by way of a standard connector **154**. The camera is therefore cross-platform compatible.

(5) In addition to receiving a video signal from the camera **110**, instructions and data can be transferred to the camera **110**, e.g., for varying the resolution and/or compression, using the same connecting USB **200**.

(6) The USB **200** connecting the camera **110** to the computer system **120** is shared by multiple devices. Thus, the video signal produced by the camera **110** may be received by any other peripherals connected to the USB **200** other than the computer system **120**, such as a modem **158**, ethernet adapter **160**, etc.

(7) By providing bit rate reduction circuitry **115**, the camera **110** is provided with registers and/or memory in which bit rate reduction capabilities of the camera **110** may be stored. Thus, the processor **128** can easily determine the capabilities of the video conferencing system **100** and transmit such capabilities to the far end, remote video conferencing system **100'** during a negotiation process. As such, the camera **110** enables automatic setup during each communication session.

In another embodiment, the camera **110** and display monitor **138** can be combined into a single device. For instance, a display monitor **138** can be provided with a camera **110** installed within the display monitor housing above the display monitor screen. Illustratively, the hub **117** of the camera is connected to a downstream serial port of the display monitor hub. The display monitor hub is then connected to the hub **150**. Such an arrangement facilitates video communication. In particular, a user facing the display screen of the display monitor at the near end, local video conferencing **100** of a communication can view a moving picture image captured by the far end, remote video conferencing system **100'** and transmitted via a network for decoding and display at the near end, local video conferencing system **100**. Simultaneously, the user's own image is captured, digitized and encoded at the near end, local video conferencing system **100** for transmission to the far end, remote video conferencing system **100'** where it is decoded and displayed at the far end, remote video conferencing system **100'**. In short, "face-to-face" communication is facilitated between a user at a near end, local video conferencing system **100** and a user at the far end, remote video conferencing system **100'**.

Such a display monitor feature can be incorporated into a common cellular phone. Many cellular telephones have data inputs that enable the cellular phone to function as a modem. Such a data input may potentially be replaced with a USB interface. FIG. **6** depicts a cellular phone **300** according to the present invention equipped with one or more liquid crystal display monitors (LCDs) **310**, **315** and camera **110**. LCD monitor **310** displays a near end, local image captured by imaging device **111**. LCD monitor **315** displays a far end remote image captured by a far end, remote camera (not shown). The LCD monitors **310** and **315** are connected to downstream serial ports of the hub **117** of the camera **110**. The hub **117** is also connected to the hub **330** of a telephone circuit **320**. Illustratively, in the example shown in FIG. **6**, the bit rate reduction circuit **115** is an H.263 compliant compressor. Illustratively, the LCD monitor **310** is also provided with a decompressor circuit **312**, such as the VCP™ (A like decompressor may be provided for LCD **315**). Note also that an additional serial port can be provided in either the hub **117** or the hub **330** for connection to a hub of a computer (e.g., the hub **150** of the computer **120** of FIG. **5**).

Illustratively, in the telephone **320**, near end, local audio is received at microphone **162** which outputs an analog audio signal to ADC **164**. ADC **164** outputs a digital audio signal to compressor **366**. The compressor **366** can operate in at least two modes. When no video is simultaneously transmitted, the compressor **366** uses an ADPCM compression technique which produces a 16 Kbit/sec audio signal. When video is simultaneously transmitted, compressor **366** uses a different technique such as CCITT's G.723, which produces a 5.3 or 6.3 Kbit/sec bit rate compressed audio signal.

The compressed audio signal is outputted to a multiplexer/demultiplexer **335** which also receives the compressed video signal outputted from hub **330**. The multiplexer/demultiplexer **335** selectively multiplexes the compressed audio and video signals and outputs the multiplexed signal to transceiver **330**. Transceiver **330** transmits the multiplexed signal via a cellular network to the far end, remote video conferencing system. The transceiver **330** also receives a multiplexed signal from the far end, remote video conferencing system via the cellular network. The received signal is demultiplexed by multiplexer/demultiplexer **335** into its constituent compressed audio and video signals. The audio signal is decompressed (by an audio decompressor not shown) and outputted via loudspeaker **340**. The compressed video is outputted via hub **330** and hub **117** for decompression and display on LCD **315**.

FIG. **7** shows an embodiment of the invention for a camcorder **400**. Illustratively, the camcorder **400** is equipped with an imaging device **410**. Such a signal may be recorded as an analog signal on a removable storage medium using a removable media recorder/player **450**. The video signal produced by imaging device **410** or removable media recorder/player **450** may be outputted via jack **460** and/or outputted to ADC **420** where it is digitized. A compressor or other bit rate reduction circuit **430** is also provided for reducing the bit rate of the digital video signal. A USB hub circuit **117** is connected to the bit rate reduction circuit **430**. Thus, in addition to the usual camcorder output **460**, which may be a composite analog video signal, a USB compliant connector **440** is provided which outputs a serial bitstream containing the video signal as produced by the USB hub circuit **117**. The USB hub circuit **117** is bidirectional and can receive information and instructions as well as transmit video signals.

In short, a camera is disclosed including a bit-rate reduction circuit connected to the CCD imaging device. Since the bit rate reduction circuitry is external to the computer system housing, the video signal can be inputted via a standard serial port having a connector external to the computer system housing.

Finally, the above-discussion is intended to be merely illustrative of the invention. Numerous alternative embodiments may be devised by those having ordinary skill in the art without departing from the spirit and scope of the following claims.

The claimed invention is:

1. A video conferencing system comprising:

a first housing,

a bus located inside said first housing,

a processor located inside said first housing and connected to said bus,

a first interface circuit located inside said first housing and connected to said bus, said first interface circuit comprising a first hub and a serial port for receiving digital signals, that are transmitted according to a predefined communications protocol, originating outside said first housing,

a communications medium located outside said first housing and connected to said first interface circuit externally to said first housing, for communicating a serial bitstream,

a second housing external to said first housing,

an imaging device located inside said second housing that converts moving pictures to a video signal,

a bit-rate reduction circuit inside said second housing and connected to said imaging device which reduces a bit rate of said video signal to a selected one of a plurality of multiple bit rates, so as to produce a bit-rate reduced video signal having a lower bandwidth than said video signal prior to bit rate reduction, such that the selected bit-rate reduced video signal being adaptable to and transferable over one of a plurality of different types of networks, each different type of network having different bit rates and different communications protocols from one another, and

a second interface circuit located inside said second housing and having a second hub connected between said bit rate reduction circuit and said communications mediun, for receiving said bit rate reduced video signal and outputting said bit rate reduced video signal as a serial bitstream on said communications medium in accordance with said predefined communications protocol

wherein said processor transfers at least one instruction packet via said bus, said first hub, said communication medium and said second hub to said bit rate reduction circuit containing an instruction indicating bit rate information of a selected one of said plurality of different networks, from one of a plurality of predetermined adjustable bit rates representing said plurality of different types of networks, independent of any bit rate information feedback from the selected network.

2. The system of claim **1** further comprising:

a modem connected to said bus, for receiving said bit rate reduced video signal and communicating said bit rate reduced video signal to a second modem via a communications network.

3. The system of claim **2** wherein said modem receives a remote bit rate reduced video signal from said second modem and wherein said processor restores said remote bit rate reduced video signal, said system further comprising:

a monitor on which said processor displays said restored remote video signal.

4. The system of claim 1 wherein said first interface comprises transmit circuitry for downloading at least one instruction packet via said communications medium and said second interface for selecting one of a plurality of said different bit rates by said bit rate reduction circuitry.

5. The system of claim 1 wherein said bit rate reduction circuit comprises a memory for storing information regarding bit rate reduction capabilities of said bit rate reduction circuit, wherein said processor transmits an instruction packet that requests retrieval of said bit rate reduction capabilities to said bit rate reduction circuit via said first interface, said communications medium and said second interface, and wherein said bit rate reduction circuit and said second interface respond to said request instruction packet by transferring said information via said second interface and said communication medium to said first interface.

6. The system of claim 5 wherein picture restoration capability information is received from a far end, remote system at said processor, wherein said processor transfers an instruction via said first interface, said communications medium and said second interface to said bit rate reduction circuit that causes said bit rate reduction circuit to reduce a bit rate of said video signal in a particular fashion to produce a bit rate reduced video signal that said far end, remote system can restore as specified in said received picture restoration capability information.

7. The system of claim 1 wherein said serial port of said first interface comprises a connector located external to said first housing and enabling connection to said communications medium totally externally to said first housing.

8. The system of claim 1 wherein said bit rate reduction circuitry comprises a video compressor.

9. The system of claim 1 wherein said bit rate reduction circuitry comprises video resolution/frame rate reduction circuitry.

10. The system of claim 1 comprising at least one peripheral having an additional interface connected to said communication medium, said communication medium carrying data communication of said at least one peripheral interspersed with said compressed video signal.

11. A video conferencing and processing terminal comprising:

(a) a computer housing containing:

(a1) an internal bus,

(a2) a general purpose processor connected to said internal bus, instruction, data and video information being transferable to and from said processor via said bus, said processor for time shared performance of data processing and processing associated with conducting a video conference,

(a3) a bridge connected to said internal bus, instruction, data, and video information being transferable to and from said bridge via said internal bus, said bridge comprising a hub, data, instruction and video information being transferable to and from said hub of said bridge in a bidirectional serial bitstream according to a first predefined communications protocol on a first external communications network,

(a4) at least one external communications interface for bidirectionally transferring at least video information and instructions between said general purpose processor and a second communications network external to said computer housing, said second communications network being of a different type, utilizing a different communications protocol, as said first external communications network,

(b) a communication medium of said first external communications network connected to said hub and located external to said computer housing,

(c) a camera housing external to said computer housing containing:

(c1) an imaging device for converting moving picture images to a video signal,

(c2) a programmable bit rate reduction circuit connected to said imaging device for reducing a bit rate of said video signal, said programmable bit rate reduction circuit for responding to one or more instructions originating externally to said camera housing by varying said reduction of bit rate of said video signal, and

(c3) a second hub connected between said bit rate reduction circuit and said communications medium, for bidirectional transfer of serial bitstreams across said communication medium, and for multiplexing said bit rate reduced video signal and instruction packets into said serial bitstreams so as to transfer said bit rate reduced video signal from said bit rate reduction circuit to said first hub and to bidirectionally transfer instruction packets between said bit rate reduction circuit and said first hub, said second hub also for demultiplexing from said bitstreams transferred on said communication medium only packets destined to circuitry within said camera housing and refraining from demultiplexing each other packet destined to circuitry external to said camera housing communicated in said bitstreams,

wherein said first hub, said second hub and said communication medium define at least part of said first external communication network, at least one of said first and second hubs comprising an additional connector for connecting a second communication medium and a third hub to form a tree topology communication network with said first hub serving as said root hub, said first and second hub responding to instructions according to said first communication protocol for adjusting a generation of, and multiplexing of data onto, bidirectionally transmitted serial bitstreams on each communication medium connected thereto to enable data transfers to originate from, or terminate at, said camera housing, said computer housing, and at least one other device connected to said first external communication network via said third hub,

wherein said processor transfers at least one instruction packet via said internal bus, said first hub, said communication medium and said second hub to said bit rate reduction circuit containing an instruction for adjusting a bit rate of said bit rate reduced video signal, according to a capacity of said first external communication network for carrying said bit rate reduced video signal, as well as information from at least one other device located outside said camera housing and said computer housing but connected to said first external communications network via said third hub, and at least one of (1) a capacity of said second external communications networks for carrying said bit rate reduced video signal, (2) a restoration processing capability of another video conferencing terminal, with which said video conferencing and data processing terminal communicates via said second external communications network, and (3) a display resolution of said second video conferencing terminal.

12. The system of claim 11, wherein at least one of said at least one other device connected to said first external communication network via said third hub being a second camera housing.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,969,750

DATED : October 19, 1999

INVENTOR(S) : Peter H. Hsieh, et. al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

The title page, item [73], the Assignee's name should read:

--Winbond Electronics Corporation--.

Signed and Sealed this

Fourteenth Day of November, 2000

Attest:

Q. TODD DICKINSON

Attesting Officer

Director of Patents and Trademarks

L Number	Hits	Search Text	DB	Time stamp
-	393208	(camera$1 or CCD or imager or (imag$3 adj1 (device or apparatus or sensor or array or pickup)))	USPAT; US-PGPUB; DERWENT	2003/09/04 15:21
-	129754	((cell or cellular or mobile) adj1 (phone or communica$4 or device or telephone)) or (radiotelephone)	USPAT; US-PGPUB; DERWENT	2003/09/04 13:34
-	302139	resolution	USPAT; US-PGPUB; DERWENT	2003/09/04 13:33
-	258972	serial	USPAT; US-PGPUB; DERWENT	2003/09/04 13:33
-	9324	viewfinder	USPAT; US-PGPUB; DERWENT	2003/09/04 14:31
-	10431	nokia.as.	USPAT; US-PGPUB; DERWENT	2003/09/04 13:33
-	37845	motorola.as.	USPAT; US-PGPUB; DERWENT	2003/09/04 13:33
-	26	ericcson.as.	USPAT; US-PGPUB; DERWENT	2003/09/04 13:34
-	123343	sony.as.	USPAT; US-PGPUB; DERWENT	2003/09/04 13:34
-	53888	lg.as.	USPAT; US-PGPUB; DERWENT	2003/09/04 13:37
-	113150	samsung.as.	USPAT; US-PGPUB; DERWENT	2003/09/04 13:34
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-	23	lg.as. and ((camera$1 or CCD or imager or (imag$3 adj1 (device or apparatus or sensor or array or pickup)))) and (((cell or cellular or mobile) adj1 (phone or communica$4 or device or telephone)) or (radiotelephone))	USPAT; US-PGPUB; DERWENT	2003/09/04 13:37
-	84	samsung.as. and ((camera$1 or CCD or imager or (imag$3 adj1 (device or apparatus or sensor or array or pickup)))) and (((cell or cellular or mobile) adj1 (phone or communica$4 or device or telephone)) or (radiotelephone))	USPAT; US-PGPUB; DERWENT	2003/09/04 13:36
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-	16	(motorola.as. and ((camera$1 or CCD or imager or (imag$3 adj1 (device or apparatus or sensor or array or pickup)))) and (((cell or cellular or mobile) adj1 (phone or communica$4 or device or telephone)) or (radiotelephone))) and resolution	USPAT; US-PGPUB; DERWENT	2003/09/04 13:57
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-	20	(viewfinder adj1 mode) and (resolution)	USPAT; US-PGPUB; DERWENT	2003/09/04 14:17
-	23	(electronic adj1 viewfinder) and (reduc$4 adj1 resolution)	USPAT; US-PGPUB; DERWENT	2003/09/04 14:18
-	95	(viewfinder) and (reduc$4 adj1 resolution)	USPAT; US-PGPUB; DERWENT	2003/09/04 15:37
-	50042	455/$.ccls.	USPAT; US-PGPUB; DERWENT	2003/09/04 14:26
-	998239	viewfinder or display or LCD or (liquid adj1 crystal) or EVF	USPAT; US-PGPUB; DERWENT	2003/09/04 14:31
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-	858	455/$.ccls. and ((camera$1 or CCD or imager or (imag$3 adj1 (device or apparatus or sensor or array or pickup)))) and (viewfinder or display or LCD or (liquid adj1 crystal) or EVF)	USPAT; US-PGPUB; DERWENT	2003/09/04 14:33
-	160	455/$.ccls. and ((camera$1 or CCD or imager or (imag$3 adj1 (device or apparatus or sensor or array or pickup)))) and (viewfinder or display or LCD or (liquid adj1 crystal) or EVF) and resolution	USPAT; US-PGPUB; DERWENT	2003/09/04 14:33
-	336	455/556.1.ccls.	USPAT; US-PGPUB; DERWENT	2003/09/04 15:10
-	83	455/556.2.ccls.	USPAT; US-PGPUB; DERWENT	2003/09/04 15:11
-	89	455/556.1.ccls. and ((camera$1 or CCD or imager or (imag$3 adj1 (device or apparatus or sensor or array or pickup))))	USPAT; US-PGPUB; DERWENT	2003/09/04 15:19
-	9	455/556.2.ccls. and ((camera$1 or CCD or imager or (imag$3 adj1 (device or apparatus or sensor or array or pickup))))	USPAT; US-PGPUB; DERWENT	2003/09/04 15:11
-	481	348/207.99.ccls.	USPAT; US-PGPUB; DERWENT	2003/09/04 15:19
-	100	348/207.1.ccls.	USPAT; US-PGPUB; DERWENT	2003/09/04 15:20
-	7	348/207.11.ccls.	USPAT; US-PGPUB; DERWENT	2003/09/04 15:20
-	42	348/211.99.ccls.	USPAT; US-PGPUB; DERWENT	2003/09/04 15:20
-	31	348/211.1.ccls.	USPAT; US-PGPUB; DERWENT	2003/09/04 15:20

-	59	348/211.2.ccls.	USPAT; US-PGPUB; DERWENT	2003/09/04 15:20
-	446	348/222.1.ccls.	USPAT; US-PGPUB; DERWENT	2003/09/04 15:21
-	194	348/333.01.ccls.	USPAT; US-PGPUB; DERWENT	2003/09/04 15:36
-	61	348/333.11.ccls.	USPAT; US-PGPUB; DERWENT	2003/09/04 15:25
-	667	348/552.ccls.	USPAT; US-PGPUB; DERWENT	2003/09/04 15:38
-	9	348/333.11.ccls. and (reduc$4 adj1 resolution)	USPAT; US-PGPUB; DERWENT	2003/09/04 16:57
-	920	(conversion adj3 accuracy) and ("A/D" or (analog$2 adj2 digital))	USPAT; US-PGPUB; DERWENT	2003/09/05 09:43
-	79296	image$1 with resolution	USPAT; US-PGPUB; DERWENT	2003/09/05 09:44
-	29	((conversion adj3 accuracy) and ("A/D" or (analog$2 adj2 digital))) and (image$1 with resolution)	USPAT; US-PGPUB; DERWENT	2003/09/05 10:21
-	14853	((low$5 or reduc$5) adj1 resolution) and ((full or high$3) adj1 resolution)	USPAT; US-PGPUB; DERWENT	2003/09/05 10:24
-	306	((low$5 or reduc$5) adj1 resolution) same ((full or high$3) adj1 resolution) same interpolation	USPAT; US-PGPUB; DERWENT	2003/09/05 10:28
-	240	(((low$5 or reduc$5) adj1 resolution) with ((full or high$3) adj1 resolution)) same interpolation	USPAT; US-PGPUB; DERWENT	2003/09/05 10:44
-	30	((((low$5 or reduc$5) adj1 resolution) with ((full or high$3) adj1 resolution)) same interpolation) and (host adj1 computer)	USPAT; US-PGPUB; DERWENT	2003/09/05 14:38

L Number	Hits	Search Text	DB	Time stamp
1	5823	(USB or (universal adj1 serial adj1 bus) or (serial) or (RS232) or (RS485)) with (wireless or infrared)	USPAT; US-PGPUB; DERWENT	2003/09/05 15:05
2	1118	((USB or (universal adj1 serial adj1 bus) or (serial) or (RS232) or (RS485)) with (wireless or infrared)) and (camera$1) and (computer)	USPAT; US-PGPUB; DERWENT	2003/09/05 15:04
3	135	((USB or (universal adj1 serial adj1 bus) or (serial) or (RS232) or (RS485)) with (wireless or infrared)) same (camera$1) same (computer)	USPAT; US-PGPUB; DERWENT	2003/09/05 15:08
4	1912	(USB or (universal adj1 serial adj1 bus) or (RS232) or (RS485)) with (wireless or infrared)	USPAT; US-PGPUB; DERWENT	2003/09/05 15:05
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6	1535	serial near5 infrared	USPAT; US-PGPUB; DERWENT	2003/09/05 15:07
7	16	(serial near5 infrared) same (camera$1) same (computer)	USPAT; US-PGPUB; DERWENT	2003/09/05 16:17